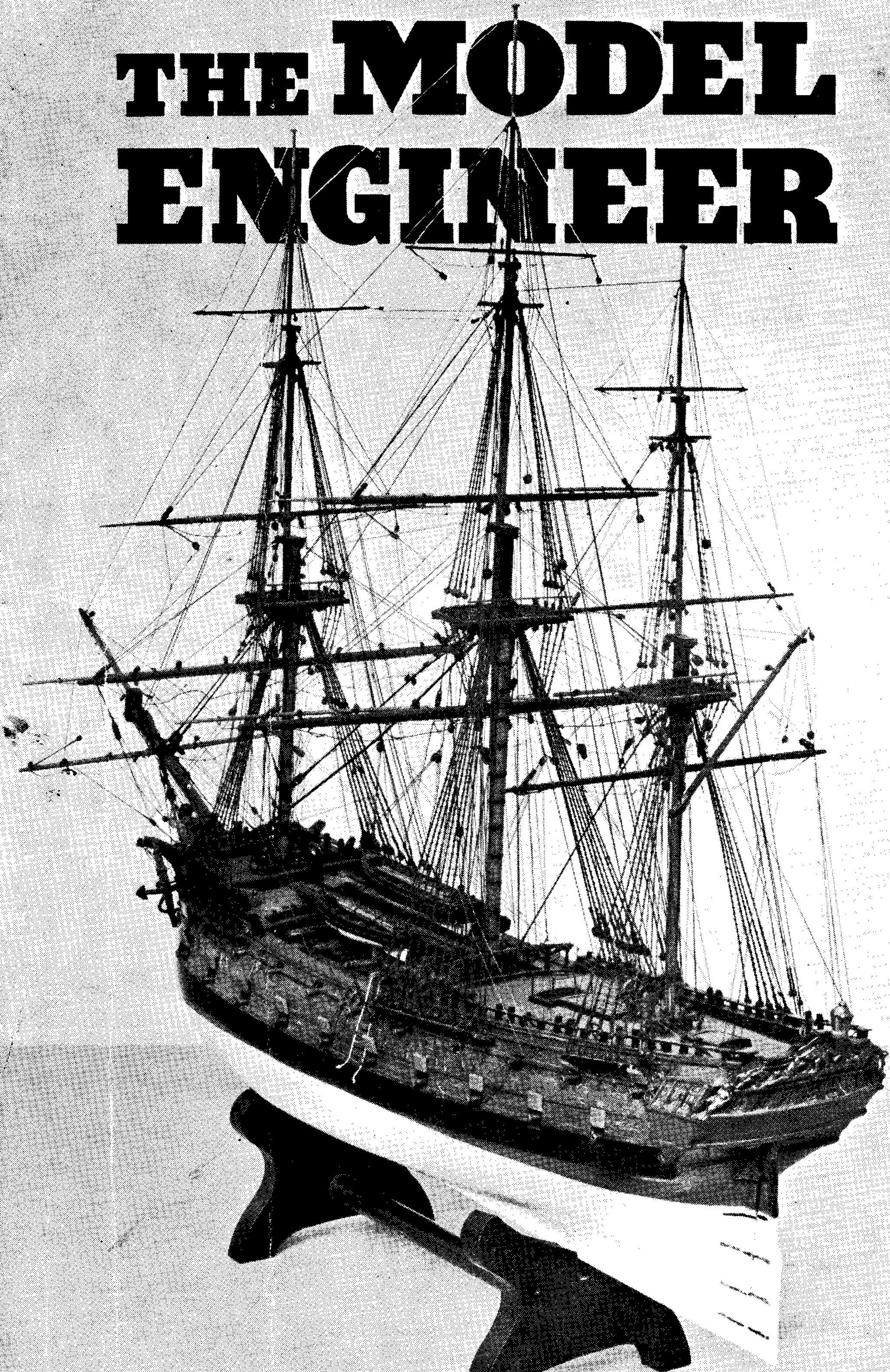
THE MODEL ENGINEER



Vol. 101 No. 2511 THURSDAY JULY 7 1949 9d.

The MODEL ENGINEER

PERCIVAL MARSHALL & CO. LTD., 23, GREAT QUEEN ST., LONDON, W.C.2

7TH JULY 1949 VOL. 101 NO. 2511

SMOKE RINGS

Our Cover Picture

● IN CONTRAST with the bone ship model used to illustrate our cover of the June 16th issue, we reproduce this week a photograph of the model of H.M.S. *Charon*, one of the twenty-five 44-gun ships built to the designs of Sir Thomas Slade between 1774 and 1786. These "forty-fours" were the smallest of the two-decker men-of-war of this period. They carried all their guns on two decks and the long quarter-deck was entirely unarmed. The model shown is an excellent example of the dockyard model of the period, and forms a valuable record, having been built and rigged from the designs of the actual ship. It is rather surprising that models of this type of ship are not made more often today by lovers of the ships of this period. Admittedly, the *Victory* has a greater historical interest, but the smaller ship is more graceful, with its easier lines and more normal freeboard. The stern and quarter galleries, the head work, and the rigging have everything of the beauty of the type, and there is not the endless repetition work entailed in making the many decks, guns and carriages, gun-ports, and fittings of the larger ships. The original drafts of practically all these ships are still preserved at the National Maritime Museum, at Greenwich, and photostat copies may be obtained, at a nominal cost, by anyone interested.

The photograph is reproduced by courtesy of the Director of the Science Museum, South Kensington.

Another "M.E." Exhibition Prize

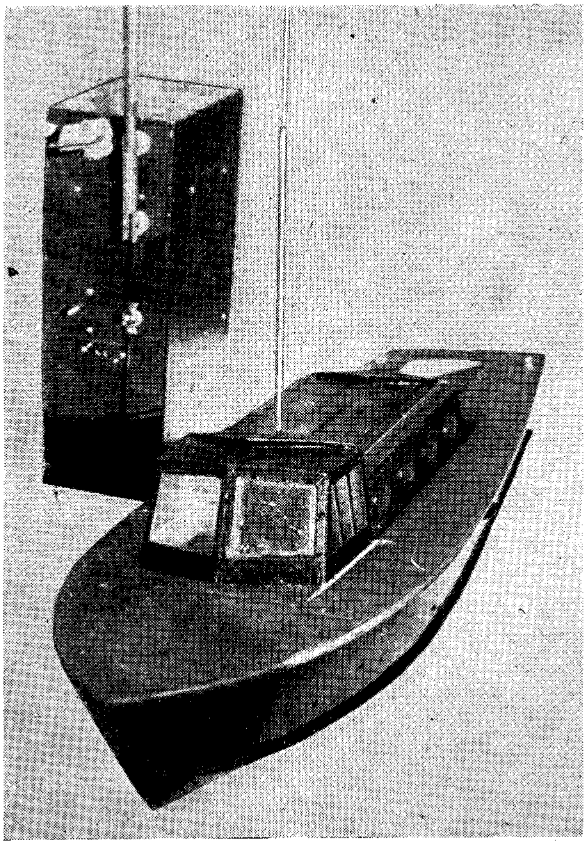
● MESSRS. KENNION BROS. (Hertford) LTD., have generously offered a voucher to the value of £5 5s. 0d., as a prize to be awarded at the "M.E." Exhibition, to the best locomotive built to "L.B.S.C.'s" specification. There is no restriction as to type or size of the engine, except that it must have been made to "L.B.S.C.'s" published instructions. We anticipate keen competition for this prize, the winner of which will be able to select from Messrs. Kennion's catalogue any articles up to the value of the voucher.

Varied Display at Andover

● THE SIX weeks between Easter and Whitsun were unusually rich in model engineering exhibitions this year; some of these shows were surprising for their scope and varied nature in localities where one might not expect model engineering to flourish. One such exhibition was organised by the Andover and District Model Engineering Society at the Guildhall, Andover, Hants, and was opened by Mr. E. D. Stogdon, Manager of THE MODEL ENGINEER Exhibition.

Support was readily forthcoming from other clubs in the Southern Federation and resulted in exhibits being sent in from Lymington, Bournemouth, Isle of Wight, Newbury, Basingstoke, Fareham, Eastleigh and Southampton. This in what is basically an agricultural district!

This show deserved better support from the public, and would probably have got it if the weather had not been quite so brilliant ; for the Guildhall, Andover, contained a more comprehensive collection of models than ever before.



Mr. Morrison's radio-controlled cabin cruiser, with the transmitter in the background

Radio-controlled Models

● ONE OF the most interesting developments during recent years is the progress in experiments with radio control of model aircraft and power boats. Although some success in this field was attained by amateurs quite early in the history of wireless communication, and for many years demonstrations in radio control were given at "M.E." Exhibitions, the availability of short-wave radio equipment and the progress in its use within the last few years, have given a great stimulus to amateur experiments, and as most of our readers are aware a Radio Controlled Models Society has been established in this country for the interchange of experimental knowledge in this subject. It is, generally speaking, easier to install a radio control receiver in a boat than an aircraft, as economy of weight and space are less critical problems, there is generally a greater time margin for the operation of controls, and risk of losing control by stalling, spinning, etc., does not arise. However, a great deal of progress is being made in both types of models. Just lately we have had evidence of the practical success of radio control in model power boats, by demonstrations at two M.P.B.A. regattas. At the Whit Monday regatta of the Bournville M.Y. & P.B.C., a local experimenter, Mr. Morrison, successfully navigated a model cabin cruiser by this means. The boat was propelled by an E.D. 2-c.c. engine and the rudder operated through a rubber-driven servo gear. At the Coventry regatta on June 18th, Mr. Welter's 4 ft. 6 in. cabin cruiser *Aurora* was shown running under radio control, and in this case a much more elaborate system was used, all motions being electrically operated, including reversal of the driving motor, which in this case was electric, and thus more adaptable than an i.c. engine in this respect. It may be remembered that *Aurora* was awarded a V.H.C. diploma in the 1947 "M.E." Exhibition, and is quite an outstanding example of model boat construction apart from experimental interest. We hope to be able to publish a photograph of the boat in our forthcoming account of the regatta. Another radio-controlled boat built by Mr. V. H. Grey also took part in the Coventry regatta, but as this boat was entered in the steering competition, it was run with the control gear definitely out of action. Incidentally, one is inclined to wonder what will happen to steering competitions when radio control of boats becomes more general.

Well Played !

● THE ROYAL NAVY is well known for its wit and humour, always in evidence when the occasion demands. We have recently heard a delightful example which, we believe, dates from the 1914-18 war period. On one occasion, the battleship *Queen Elizabeth* met a merchant-vessel bearing the same name. The battleship, by way of salute, promptly signalled "Snap"!

The "M.E." Index

● ANOTHER VOLUME of THE MODEL ENGINEER has now been completed and we repeat our offer to supply subscribers and regular readers with the index for Volume 100, if they will send us a stamped addressed envelope (1d.) of sufficient size to take a copy of the journal flat. The index will not be printed until we know how many copies are required to fill the demand, but readers are requested to make early application to the Sales Manager, THE MODEL ENGINEER, 23, Great Queen Street, London, W.C.2.

Show Models in South Africa

DURING the Witwatersrand Agricultural Society's Rand Easter Show held in Johannesburg, the Rand Society of Model Engineers held their annual exhibition. Entries for the gold medal donated annually by the Witwatersrand Agricultural Society and the eight floating trophies, came from as far afield as Cape Town, from whence, also, a number of the members came to give a helping hand.

All previous records went by the board, and models placed on exhibition totalled some 150. These covered all the sections of engineering, and the quality of workmanship was of a very high standard. In addition to these there were a large number of models on "loan" onl

Entrance to the exhibition was free to visitors to the Witwatersrand Agricultural Society's show, and it was therefore only possible to estimate the number of people who passed through to the model engineers' section. Visitors to the main show for the period totalled 442,633, and it is conservatively estimated that at least 150,000 must have visited the Rand Society of Model Engineers' pavilions.

The "OO"-gauge layout appeared to be the main attraction to the public, who at times were standing six deep. The automatic train completed up to 50 miles, running without a hitch, whilst

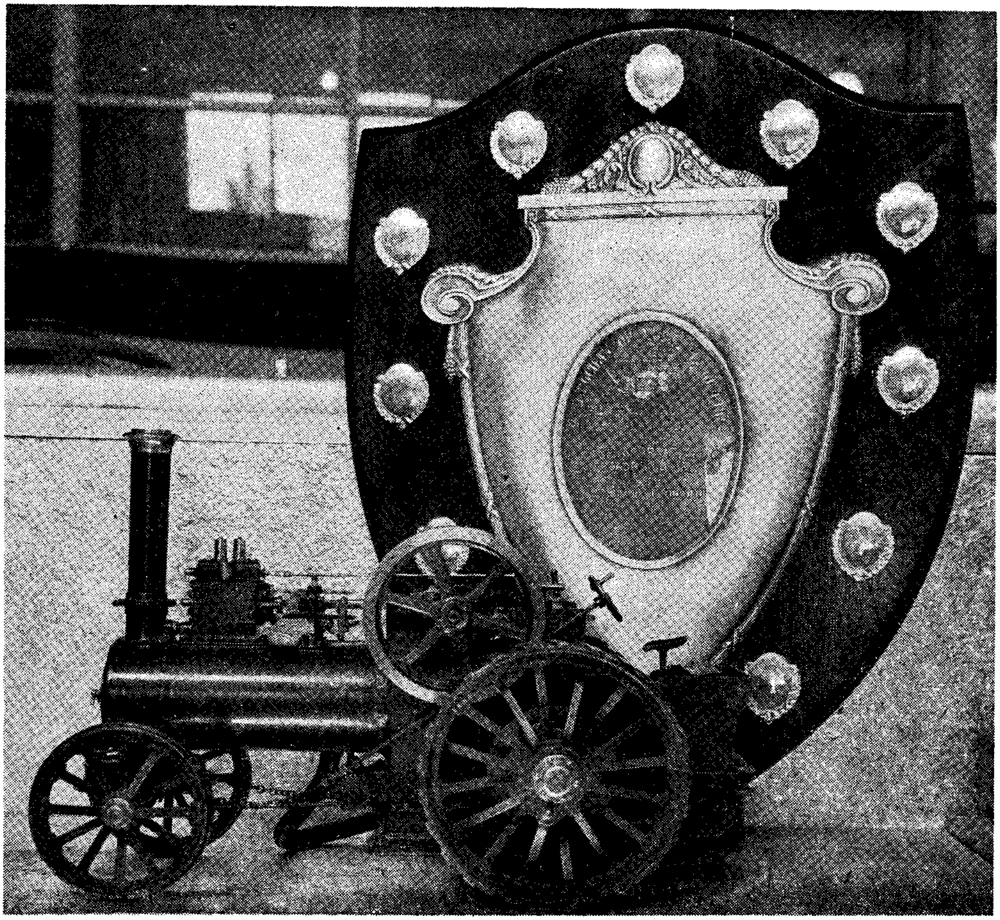


Photo by] [*Industrial Photography (Pty.) Ltd.*

Mr. H. Marshall-Smith's 1-in. scale Davey Paxman traction engine, winner of the B.M.S. Shield

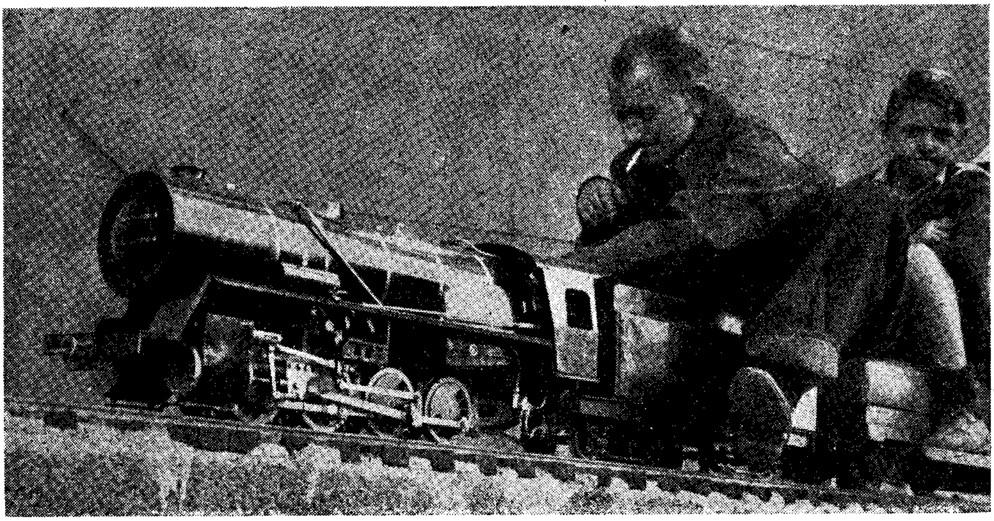
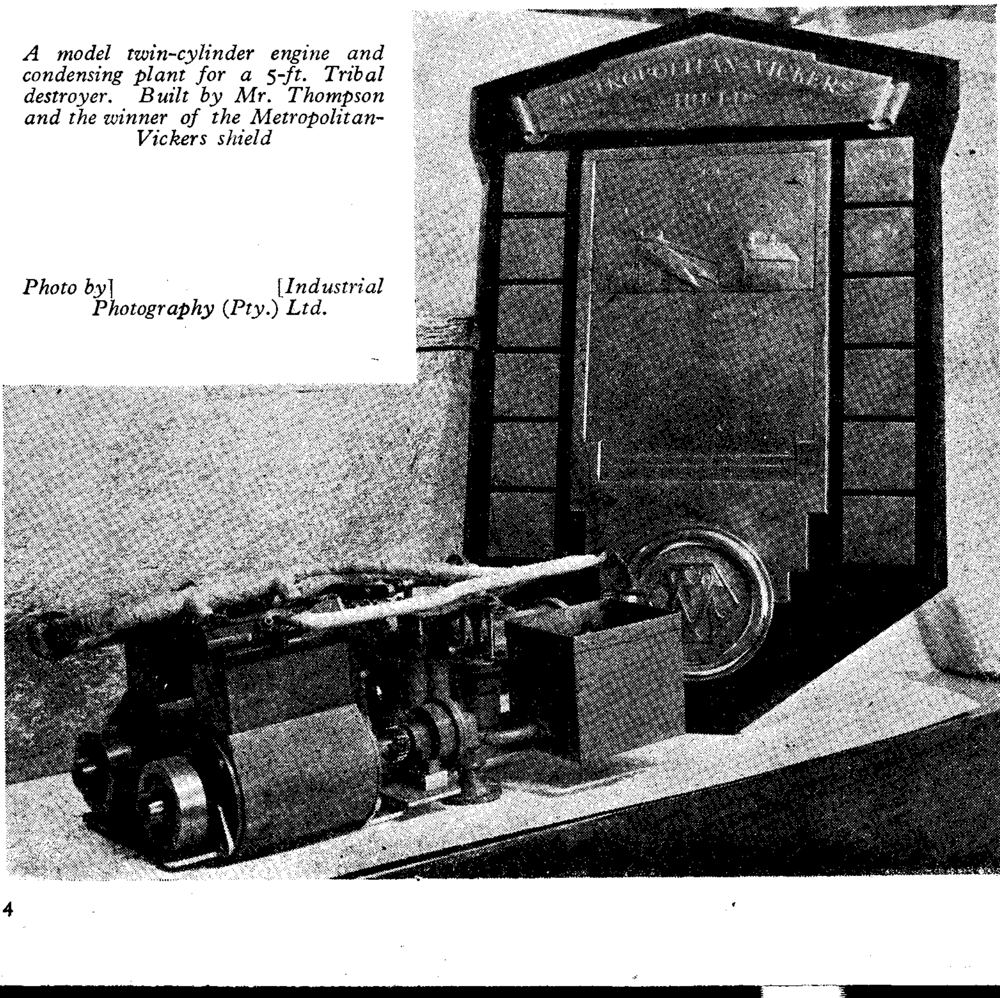


Photo by] [*R. Holmes*
Mr. J. Armstrong, the builder and driver, with his 3½*-in. gauge S.A. Railways S.*1 *class locomotive*

A model twin-cylinder engine and condensing plant for a 5-ft. Tribal destroyer. Built by Mr. Thompson and the winner of the Metropolitan-Vickers shield

Photo by] [*Industrial Photography (Pty.) Ltd.*



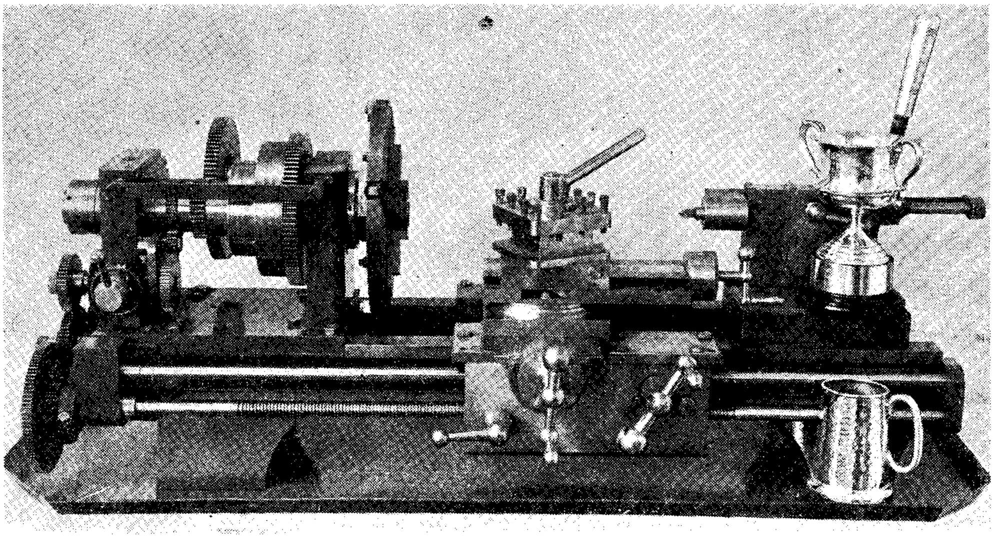


Photo by] [*Industrial Photography (Pty.) Ltd.*
A 6-in. bench lathe, built by Mr. W. E. Bick, winner of the Stewarts and Lloyds cup

members' locomotives and carriages running continuously intrigued the public with their performances.

The "O"-gauge layout, still in its infancy, was also a centre of attraction, whilst the permanent "live steam" track, built during the preceding twelve months certainly came up to the members' expectations. This latter track, oval in shape and 380 ft. in length, is built at present to take up to 5-in. gauge. During the eight days of running, 9,694 children and 1,153 adults were given rides in 1,298 trips, the total distance covered by two of the locomotives jointly being 100 miles.

Model engineering is becoming one of the most popular hobbies in South Africa, judging by the number of enquiries for membership. The Rand Society of Model Engineers alone has practically doubled its membership in the last two years.

The models are housed in three halls and additions to the existing premises are necessary to accommodate the exhibits which are expected to arrive from every corner of South Africa for the 1950 "World of Models Exhibition."

A model $3\frac{1}{2}$-in. gauge free-lance British Austerity type locomotive. Builder and driver, Mr. S. Churchill

Photo by] [*R. Holmes*

" The Jockey "

Improvements and Innovations

No. 2—Dangerous Driving!

by "1121"

THE Society of Model and Experimental Engineers is inaugurating a system by which passenger-hauling locomotive drivers may be classified according to their experience, competence and record of safe driving. This scheme was originally suggested by several of the Society's affiliated bodies, and was subsequently received with such enthusiasm by the Affiliation Committee that this committee is largely taking over the organisation of the work involved.

The object of the scheme is not only that of safeguarding the Society's locos, and the public, on the occasions when they come together, and enabling the Society's track committee to hand over its equipment for use by those requiring it, with the knowledge that it will only be handled by competent people, but also that of providing the affiliated societies, or any other societies, for that matter, with some check on the desirability of persons turning up to " help " at local exhibitions, etc., whether the persons are members of the London Society, some other organisation, or private individuals.

It is proposed, with the Editor's permission, to report on the preparation and operation of this scheme in due course; in the meantime, it might be as well to decide just what constitutes a " safe " driver, and the best way to do this is by a process of elimination, by studying the various *unsafe* trends to be observed in certain types of drivers. As a result of long observation, we are able to classify these under the following headings, and we are being deliberately brutal. We will not, of course, mention any names, or publish any photographs to substantiate our observations, but we cannot prevent the trying on of any headgear which appears to be of the right size. We will start off then with :—

" The Jockey "

This gentleman treats his engine as a racehorse, and the track dead-ends as winning posts. He can't pass them without doing a fair amount of damage, but he consoles himself by achieving the highest possible speed at the shortest possible distance from the ends of the track. He flogs his engine to its last ounce for as long as possible, and pulls up with a screech of brakes, bringing his buffers to within an inch of the dead-end. We like a driver to get a move on, and not waste undue time with each load when a queue is waiting; but at the same time we can tolerate his allowing himself a yard or so above the absolute minimum for pulling up, to give himself the chance to deal with any emergency which may arise.

On the occasions when another engine is being got ready, or taken out of service, on the front end of the track, this type of driver is an unmitigated nuisance. His habit of stopping as close as possible to the tender of the second engine, if not actually touching it, is annoying, to say the least of it, when one is wanting to manipulate the tender while joining or dismantling the hose connections, with one's finger inserted under the wheels or between the drag beams. Furthermore, for some reason not yet explained, this type of driver almost invariably has his blower turned hard on the whole time, and causes grave discomfort to one's ear, by insinuating his chimney beneath it on these occasions, to say nothing of treating it to a shower of sparks when he slips his wheels violently on starting back.

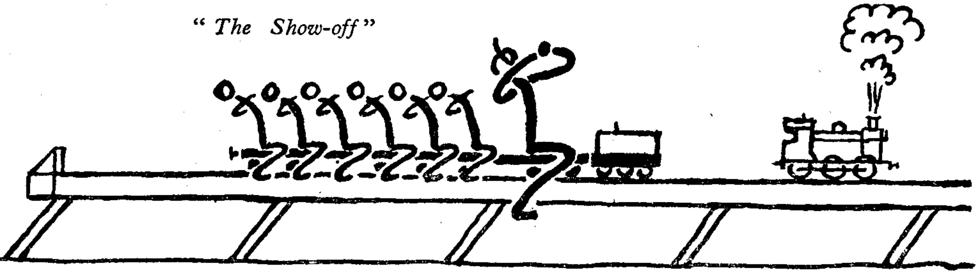
We must say, however, that in our experience this " all-out " style of driving is not the commonest cause of accidents. After a period of driving, the man gets to know his engine, his average train weight and the power of his brakes, and his peculiar method of driving itself ensures a proper concentration on the controls. For this reason he is not nearly such a menace as—

" The Show-Off "

This is the man who considers that *he* is the object on exhibition, which the public has come to see, and that the engine is merely there as an instrument with which to display his skill. He regards it as a concert pianist might regard his piano. To the harassed track superintendent, upon whose shoulders the responsibility for any accidents descends, the driver is an appendage of the machine, unfortunately necessary, constituting a large proportion of the dead-weight of the train, and introducing the human element to cause accidents for which the engine itself could not be responsible. This type of driver distinguishes himself by the following routine on starting a heavy train of trusting passengers :—

1. Slam open regulator.
2. Sit back on truck, wiping hands on piece of rag kept handy for the purpose.

"*The Show-off*"



3. Beam round at admiring audience, or better still at passengers behind, with beatific smile of achievement.

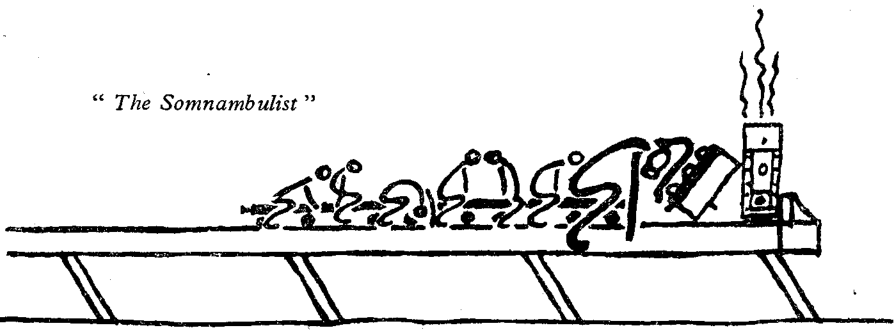
It will be appreciated that by this process he effectually removes any possibility of doing anything should the unexpected occur. If his engine strikes a spot of oil and starts slipping, the audience is treated to a more spectacular sight in a grand firework display from the chimney, which removes most of his fire before he can get to the regulator. In the more serious event of a coupling breaking, which *has* been known to happen, the engine is away before he is able to do anything to stop it. A driver who keeps his hand on the regulator, or at least in the cab, stands a good chance of shutting off steam in a hurry : for that matter, many an engine has been saved because the driver was able to grab hold of the cab before it got away, and hang on to it until someone was able to shut off steam for him. Keeping hold of the tender is better than nothing, but does not cater for an engine's racing off without its tender should a drawbar pin get hooked out, or not be put in properly.

"The Somnambulist"

This driver becomes lulled into a deep sleep, possibly by the rhythmic exhaust-beat of his engine, or the atmosphere emanating from its chimney, or a combination of the two. While he is in this condition the tender becomes a kind of perambulating divan, on which, more or less unevenly, he spreads his weary weight. The trouble arises when he can no longer balance on the limited area available, and lolls over to one side. This invariably derails the tender, the resulting bumping and barrage of coal, water and firing-tools, causing the driver to awaken with a start. Before he can ask where he is and what he is supposed to be doing, the loco has become derailed as well, and is only saved from disaster by the remainder of the track staff rushing to the scene and stopping the train. Readers may believe us or not, but we have actually known drivers so far gone that they have fallen overboard sideways, taking train, engine and passengers with them.

We hope that, should any readers perceive a similarity between any of our observations and his own particular style of driving, he will consider carefully before dismissing his own attitude as correct and ours impertinent, and will appreciate our motive of endeavouring to ensure the greatest possible freedom from trouble when carrying the public. We beg him to realise that one really good accident at an exhibition or similar function might have serious repercussions likely to affect all other clubs ; we do not believe in imposing all sorts of printed rules and regulations on a gang of enthusiasts co-operating in voluntary work for the benefit of a good cause, and would much rather know that the team as individuals appreciates its responsibility towards each other, each other's engines, and the public and behaves accordingly

"*The Somnambulist*"



We do not wish to alarm readers into thinking that engines are always galloping off on their own, but those used to handling a gun know that they make a point of avoiding pointing it at anybody for fun, practice, or anything else, however well they know that it cannot possibly be loaded. It's the *habit* that counts, and on the occasions when accidents have happened with both engines and guns, investigation has almost invariably shown that they *could* have been avoided had the person whose responsibility it was to be in control of the gun or engine been trained in *automatic* "safety first."

The next "dangerous driver" on our list we will term—

PETROL ENGINE TOPICS

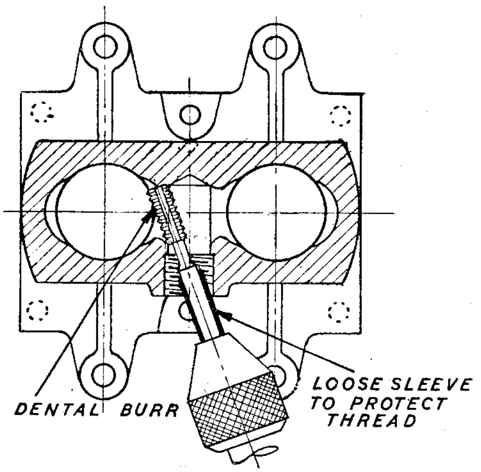
*A Twin-Cylinder 2.5 c.c. Compression-Ignition Engine

by Edgar T. Westbury

THE bores of the three main bearing housings, in the engine body and sump assembly, should be held closely to the diameter specified, namely, $\frac{3}{4}$ in. diameter, because although a dimensional error is not a major calamity, it will make the fitting of the mating parts, and in particular the centre split bearing, more difficult. If the assembly has been properly set up, there should be no necessity to machine the chambered portions of the crankcase between the bearings. To face the remote end of the assembly, it is advisable to remove it from its bearers on the angle plate, and mount it on a true-running $\frac{3}{4}$ in. mandrel between centres.

The main inlet port in the body casting may be bored and faced by mounting either the complete assembly on its bearers, or the body part only, on the angle plate with its axis parallel with the faceplate. While this particular operation could be done in the drilling machine, it is much better to do it in the lathe as described, not only because one is much more certain to get the hole exactly where it is wanted, but also to facilitate clean facing of the boss. Centre the hole accurately and start the drilling with a centre-drill, following up with an undersize drill to specified depth, and then the tapping drill. As the latter may break into the eccentric grooves in the bores of the casting, caution is necessary at this stage, and here is another reason for carrying out the operation in the lathe, rather than the drilling machine, where control of drill feed is more difficult. It may be found easier to carry out the drilling operation before machining the eccentric grooves, as already mentioned. The tapping of the hole should be carried out with equal care, before dismounting the work from its setting. If it is intended to fit exhaust pipes to the engine, the exhaust flanges should also be faced, which is easily done by setting the casting over till each exhaust port in turn is roughly central. Only a mere skim to clean up the face is required. Alternatively, the flanges may be faced by milling.

To complete full communication between the main inlet port and the eccentric grooves, a little manoeuvring with a rotary cutter is called for ; while it is helpful if one has a flexible shaft or a motor hand tool for this job, it can be done in the lathe or drilling machine, the work being held in the hand and manipulated as required. The most useful form of cutter is of the " excavator " type like a small rotary file ; it is entered at an angle, to work against the side of the hole, and care should be taken not to damage the tapped hole at the mouth. A good method of avoiding this is to make a thin brass bush to run freely on the shank of the cutter and prevent it coming into contact with the threads.



Method of fairing out inlet passages with a rotary cutter

Main Bearing End-plates

These call only for a brief description, as their machining is simple, and the essential work can be carried out at one setting. The castings are provided with chucking pieces, which have a slight taper for reasons concerned with the production of the casting, and it is advisable to skim this parallel, by holding the component by the flange end, before carrying out the main machining.

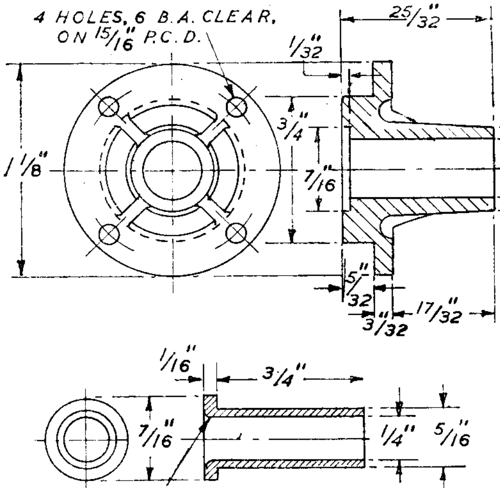
Face the end of the spigot and centre-drill it, following up with an undersize drill, not larger than 9/32 in., to the required depth. If there is the least doubt as to the truth of the drilled hole, a smaller pilot hole is advisable, a boring tool then being used to open out the hole to within one or two thousandths of an inch of finished size, when a reamer or D-bit may be inserted. Complete the facing and recessing, also the outside machining of the spigot, which is made a close fit in the bore of the crankcase housing ; the outer edge and the back (i.e., outside) face of the flange can also be machined, prior to parting the work off at a distance of 25/32 in from the spigot face, or $\frac{5}{8}$ in. from the flange face.

Main Bearing Bushes

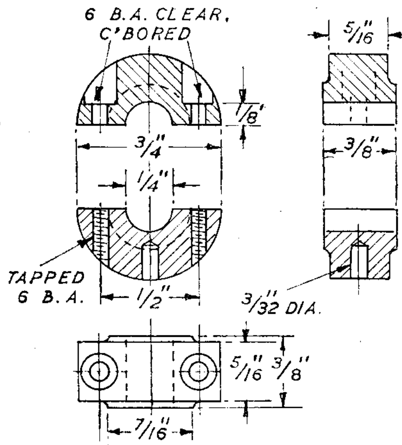
These also are straightforward to machine, so long as due care is taken to keep the bore and the outer surface truly concentric, which can be done by making them at one setting from a piece of bronze stick. They should have about 1/1,000 in. interference fit, a very slight taper being allowed for the first $\frac{1}{4}$ in. or so to facilitate entry,

*Continued from page 775, Vol. 100, " M.E.," June 23, 1949.

and are pressed into the endplates in the vice or drawn in with a long ¼-in. bolt, the latter being generally better as it prevents the bush getting out of line with the hole. I encounter many cases of badly fitted bearing bushes, some being so badly finished outside, and the bores of the housings likewise, so that they touch only a few high spots, and thus soon become loose, while others are given far too much interference or heavily tapered, then bashed in with a hammer or otherwise subjected to brute force, with consequent distortion or splitting of the housings.



End bearing housings and bushes



Split centre bearing

There is no room for this sort of thing in a tiny engine, neither is it beyond the ability of the constructor to carry out the operation of fitting a bush as it should be done. It will usually be found necessary to reamer the bush after it is inserted, owing to contraction of the bore caused in pressing in. Don't forget the slight radius to clear the fillet of the shaft. Both endplates and bushes are identical for the two ends of the crankcase, and they are each secured in position by four 6 B.A. screws, as seen in the perspective drawing on page 693, June 9th issue.

Split Centre Bearing

There are two methods of machining this bearing, either of which will produce the required result; the first is to rough out the bearing in the solid, leaving the outside well oversize and drilling an undersize hole. The bearing is then split with a narrow saw, and the faces trued by filing or machining, followed by lapping, after which the two screw holes are drilled and tapped, the clearance holes in the top half counterbored, and the halves clamped firmly together. They are then set up in the chuck and one side faced, the centre hole being bored to size at the same setting. A mandrel is then used to mount the work for turning the outside diameter and facing the other side.

In the alternative method, which I prefer, as it reduces the number of separate operations and the possible sources of error, a piece of bronze bar long enough to make the bearing with allowance for chucking, and of adequate diameter, is first split on the centre line, and the faces machined and lapped flat, after which they are tinned, and the two halves sweated together. To ensure proper contact of the faces, they should be put under clamping pressure while hot, so as to squeeze out superfluous solder. After cooling, the work is held in the four-jaw chuck, the dividing line being diagonal to the position of the jaws so that two jaws bear firmly on each half; the line should also be exactly central relative to the lathe axis. It is now possible to carry out nearly all the machining on the bearing, including boring, turning and facing on one side, before parting off, leaving only a mere skim to be done on the other side, with the bearing mounted lightly on a pin mandrel.

The two halves of the bearing are unsweated and the faces wiped clean while hot, after which the holes for the two screws are drilled in each half. In either case, it is advisable to start the holes from the flat face, the clearance holes being drilled first and counterbored with a piloted pin drill from the other side. Then the halves are clamped together, with a ¼-in. mandrel inserted in the hole to ensure their correct relative location, and the tapping holes in the lower half spotted through from the holes in the top half. The location hole in the lower half of the bearing should not be drilled until all the components of the engine are ready for assembly. Mark the two halves of the bearing on one of the faces, so that they can always be assembled in correct relation to each other.

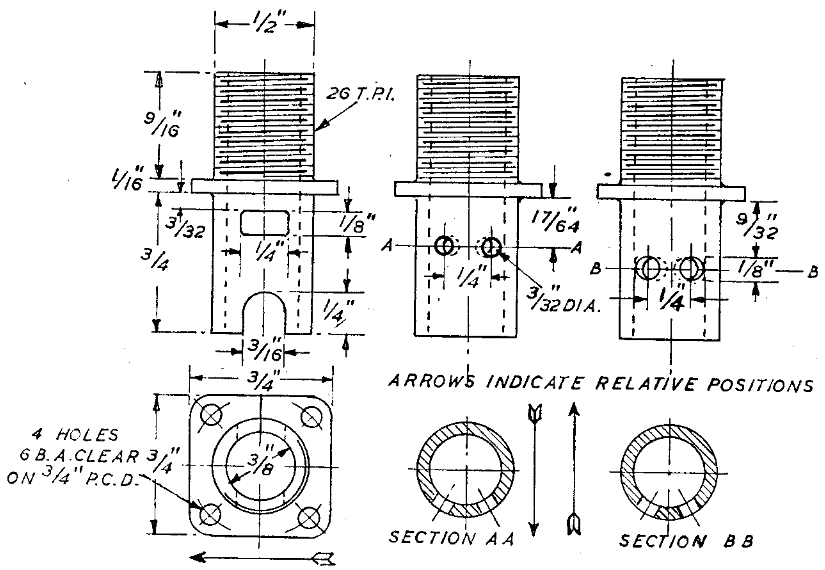
It will be noted that the centre bearing forms a sealing diaphragm against differences of pressure in the individual crankcases, therefore it is most important to avoid gas leakage at the joint between the halves, and also around the

outer edge of the bearing. If the bearing is made to a good push fit in the centre housing, and is given a coating of fairly thick shellac varnish or a jointing preparation, no trouble will be encountered in this respect, but it will be evident that care is called for in fitting, also in the counter-boring of the screw holes, and the removal of burrs formed in the course of these operations. Lapping of the bearing by means of a ring lap, to ensure its fit, may be found worth while, and if this is to be done it must be left slightly over-size in the machining.

Cylinder Liners

The material recommended for these is carbon steel, such as ordinary tool steel, which should be annealed before machining and used in this condition without subsequent heat treatment. Attempts to harden the cylinder liners of these small engines are not usually successful, due to the liability to distortion, and the hardening may not be permanent, as the cylinder temperature is often sufficiently high to blue the steel and let down the temper. Carbon steel is not the best material on earth to machine, but the amount of metal to be removed is not very great, and with good tools, a little care and patience will overcome any difficulties encountered. As an alternative, mild-steel liners, with the bores deeply carburised, such as I have described on previous occasions, may be used; cast-iron, unless of very special quality, is deficient in mechanical strength to cope with the high pressures encountered in c.i. engines.

The method recommended for machining the cylinder liners is to hold them in the four-jaw chuck at one end, for facing, centring and drilling, the holes being left well undersize at this stage. At the same setting, the upper part of the liner can be turned to size and the thread cut. Machining operations on carbon steel call for sharp, well-set tools, with moderate top rake, and they should not be allowed to become dull or the material will drag or glaze. A lubricant such as cutting-oil diluted with paraffin, or thin water-base soluble cutting compound, may be found helpful, but many operators prefer to machine carbon steel dry. Screwcutting calls for special care, and should be done in easy stages to reduce the risk of chipping the tool point. The use of a sharp hand-chaser, well lubricated, will assist in getting a finish on the threads.



Details of cylinder liners

To machine the skirt of the liner, a chucking piece may be made from any convenient bit of material, held in the chuck and drilled and tapped truly to take the screwed end of the liner. The mouth of the hole should be bored out just enough to clear the threads and allow the liner to screw right home against its flange. The lower end can now be turned down to finished size, which should represent a tight push fit in the bore of the seating in the body, and any difficulty in obtaining the required fit and finish may be dealt with in this case also by leaving slightly oversize and lapping with a ring lap. At the same setting, the cylinder bore may be machined with a single-point boring tool to within about 0.002 in. of finished size; if desired, a D-bit made to this dimension, keenly honed and well lubricated, may be put through at slow speed to obtain as high a machined finish as possible.

The lapping operation on the cylinder bore is the most important operation in the whole engine construction, and in my own case, was also much the longest operation, the work on the two bores occupying practically ten hours altogether for the removal of only two thousandths of an inch of metal! No doubt it could be done

much quicker, but no matter how long it takes it is worth while if it produces the necessary accuracy, which is more likely to be obtained by slow easy stages than by rushing things. The rough lapping was carried out with fine carborundum paste on an aluminium expanding lap, followed by aluminium oxide (which was recommended by a reader who used it very successfully on a "Craftsman Twin") and tripoli on separate copper laps, also of the expanding type fitted to the same taper mandrel as the rough lap. I find the expanding lap practically essential, especially in the finer stages of lapping, as it enables any inaccuracy to be felt by the variation of friction, and at each stage the lap should be kept well up to the bore size, as a slack lap is very difficult to control besides giving no indication of local inaccuracy. In the final stages the lap needs to be practically a "squeaking fit," and must not be run too fast or the work will heat up rapidly. I also regard it as essential to hold either the lap or the work in the hand (preferably the latter), as a sensitive feel of the lap cannot be obtained when both it and the work are rigidly located in the lathe or drilling machine.

After the major stages of lapping are completed, the ports should be cut in the cylinder wall, which will nearly always entail some slight distortion, apart from the burrs raised around the edges of the holes; but really heavy lapping after cutting the ports should be avoided if possible, as it is liable to cause rounding off of the inside port edges, and thereby give false timing of the point of cut-off.

(To be continued)

For the Bookshelf

Atomic Energy, by Karl K. Darrow. (London: Chapman & Hall Ltd., 37, Essex Street, W.C.2.) Price 12s. net.

The subject of this book is one that is very widely discussed, but little understood, at the present time, and the author, a well-known physicist associated with the Bell Telephone Laboratories, of U.S.A., has set out to explain it in simple terms, but without sacrifice of accuracy. In its original form, the text of the book consisted of a series of five lectures, dealing progressively with the nature of the atom as the basic element in the structure of matter, the history of atomic research, leading to the collapse of former theories on the undivisibility of the atom, the theory of nuclear fission, and the means whereby atomic energy in various forms can be liberated. In contrast to the dry-as-dust treatment of advanced scientific subjects which is all too common, this book makes interesting, indeed entertaining, reading and can be recommended to intelligent readers who wish to keep in touch with the rapid march of science.

Technical Metalcraft for Schools, by J. R. Ferguson. (London: B. T. Batsford Ltd., 15, North Audley Street, W.1.) Price 7s. 6d. net.

This book is stated to be "a course of practical instruction intended to develop skill in craftsmanship through the medium of present-day methods of metal working." Its object, therefore, is a very worthy one, and not only more far-sighted than many of the books which form the basis of technical schools curricula, but deals with the subject in a more practical and up-to-date way. All processes which involve the measuring, marking and cutting out of metal with either hand or machine tools are dealt with, also the heat-treatment of carbon steel. Practical exercises in these processes are given, including construction of a number of simple and practical tools, all of which are fully illustrated by detail drawings. The book should be extremely useful to the engineering student or apprentice, but is by no means devoid of interest to craftsmen of more mature experience.

Questions and Answers on Diesel Engines, by E. Molloy. (London: George Newnes Ltd., Southampton Street, Strand, W.C.2.) Price 5s. net.

The modern diesel, as employed for road transport, marine and stationary work, has now assumed an importance equal to that of any other prime mover, and the special technique required in its handling, maintenance and adjustment opens up a new field of engineering technology. In this book, the subject is dealt with in the form of questions and answers which cover general principles, types and construction, fuel injection, governing, operation, maintenance and testing. Numerous illustrations, mostly line drawings, are included in the text, and the book should be very helpful to students preparing for examinations on the subject of diesel engines. To avoid possible misunderstanding, note that the book does *not* deal with miniature model "diesel" engines.

Basic Technical Electricity, by H. Cotton. (London: Cleaver-Hume Press Ltd., 42A, South Audley Street, W.1.) Price 8s. 6d. net.

This is the first of a series of handbooks dealing with various aspects of electrical engineering, and forms an introduction to the subject. It begins with a chapter on the nature of electricity, followed by others on sources of electricity, practical methods of utilisation, chemical, mechanical and thermal effects, magnetism, induction, static electricity, units and methods of measurement. Finally, questions and answers relevant to the subject matter are appended at the end of the book. Numerous illustrations in line and half-tone, including six full page plates, are given. A useful book for students preparing for examinations in electrical subjects.

The Working of Metal Pipes

by J. W. Tomlinson

PIPE bending in engineering comes chiefly under coppersmithing, that is, when the pipes are " one off " jobs and manipulated without the use of special appliances. Now coppersmithing is considered one of the more skilled trades, but the model maker need not despair on this account, as the working of pipes, if carried out correctly, can be quite an easy job.

Annealing

Before any attempt is made to bend a pipe, it should be assured that the metal is as soft as possible. This state is brought about by annealing. To anneal brass and copper piping, heat it over the bunsen burner or blowlamp until it is red hot, then plunge it into a bucket of cold water. Steel piping must be heated in a similar manner until it is at least a dull red, but instead of quenching, allow to cool in still air. To anneal aluminium piping, heat it over a soft flame, and, after one or two minutes, rub the pipe with a piece of soft wood ; as soon as a black mark appears on the pipe it is annealed and should be allowed to cool.

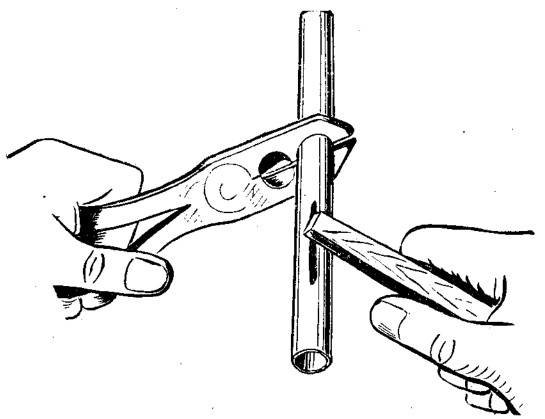


Fig. 1. Check the annealing temperature of aluminium tube with a piece of wood

Bending

The bending of small pipes up to $\frac{1}{4}$ in. diameter offers no difficulty unless the bends are very acute. With acute bends the pipe may become oval at the bend, looking unsightly and restricting the flow. One method of preventing this ovality is to thread a length of Bowden type outer cable through the pipe before bending is carried out. The cable should be of a slightly smaller diameter than the pipe bore, so that it can easily be withdrawn. A piece of expanding curtain wire or an old push-bike brake cable can be used for this purpose. If the cable becomes tight after the bend is made, it can be freed by light hammering on the side of the bend with a peening hammer.

Another method to prevent ovality on the bend, is to fit a closely coiled spring around the outside of the pipe, locating it where the bend is to be made, as shown in Fig. 2. Different methods will have to be employed when bending larger diameter pipes, and, although pipes of, say, $\frac{5}{16}$ in. bore upwards are only occasionally used

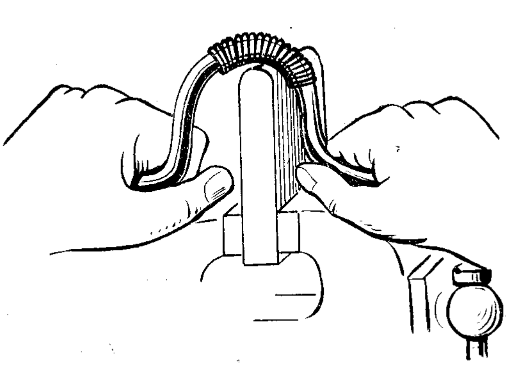


Fig. 2. An easy way of bending pipes without filling is to fit a closely coiled spring over the pipe

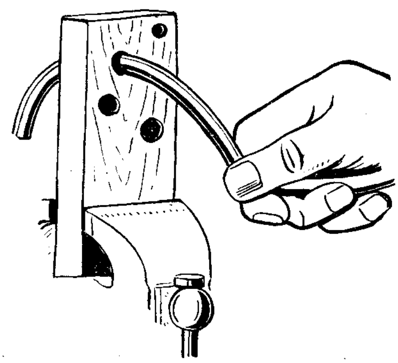


Fig. 3. A piece of wood drilled with various sized holes will assist in making the bends

for model making, a few notes on the matter should not be out of place. There are, of course, various pipe-bending machines on the market, but these are out of the question for the model maker, so we shall have to resort to the method of filling the pipe so that it keeps its shape while making the bend.

Filling Materials

The three most popular materials used for filling are sand, lead, and a metal with a very low melting point such as "Cerrobend." Use of the latter material is the most up-to-date method and is to be recommended. In each case the pipe is stood on end and the material poured in. If sand is used, it is most important that the sand and the pipe are perfectly dry, as any subsequent heating of the pipe for additional local annealing may cause an explosion. Therefore, the pipe and the sand should be heated before it is used to ensure the removal of all moisture. When using sand, first drive a dry wooden plug into one end of the pipe, pour in the sand and plug the other end. The pipe is then ready for bending. A piece of thick wood with suitably sized holes drilled in it can be used to assist in making the bend (see Fig. 3). If the pipe is above $\frac{3}{8}$ in. outside diameter, it should be bent a little at a time with intermediate peenings on the inside of the bend to remove any ridges which may form.

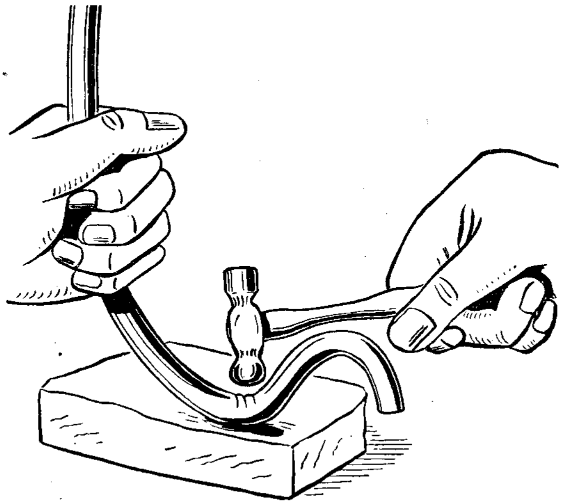


Fig. 4. The filled pipe should be peened on the inside of the bend if ridges appear

Peening

When peening, the pipe should be placed on a small bag of sand or on a block of wood or lead, and if the pipe has to be worked excessively, it should be locally re-annealed, not forgetting the warning about damp sand. When lead is being used as a filling, it will be necessary to form a seal around the bottom of the pipe as the molten lead is being poured in. Clay or asbestos string will serve for this purpose, no plugs being needed. The bending is carried out as with the sand filling, but it should be borne in mind that local re-annealing will not be possible with a lead-filled pipe. When melting the lead out of the pipe, great care must be taken to proceed from one end, gradually working along the pipe.

The use of low melting-point metal makes the process of filling much more convenient. The metal should be heated in something after the style of a glue kettle. If the water is kept at just below boiling point the metal should completely fuse ready for pouring. The pipe should be pre-heated and preferably oiled on the inside diameter. The oiled surface will prevent the metal sticking to the pipe. For filling, the pipe can be plugged or a seal of clay can be placed around the bottom, and care should be exercised in pouring to avoid air locks. The metal cools off very slowly, so it should be ascertained that it has completely solidified before the bending commences. It is a good plan to cool the pipe off in cold water. To empty, either place the pipe in hot water or pour hot water over it, finally pouring some water through the pipe to remove all traces of metal, which can be collected from the water and used over again.

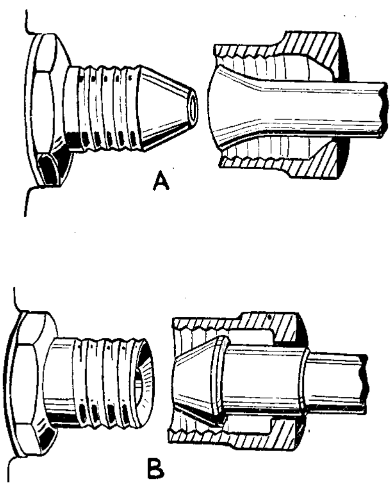


Fig. 5. Two types of end fittings suitable for model makers

Aluminium pipes should be bent as soon as possible after annealing due to age hardening, and all pipes should be re-annealed after they are emptied.

End Fittings

There are two types of end fittings which can be recommended for the model maker, and if these are used with the various unions and connections they should serve for most purposes. The two types are shown in Fig. 5. The one shown at *A* requires no brazing or soldering and the parts are easy to make. The pipe can be belled or flared out, using a split wooden block and punch, as shown in Fig. 6. Before belling out

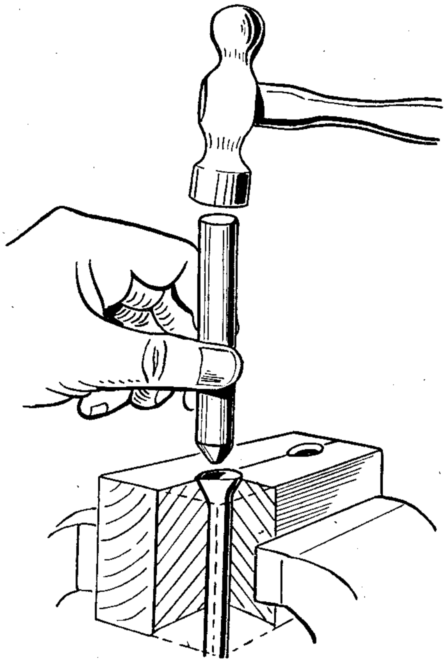


Fig. 6. Flaring can be carried out with the aid of a suitable punch and a split wooden block

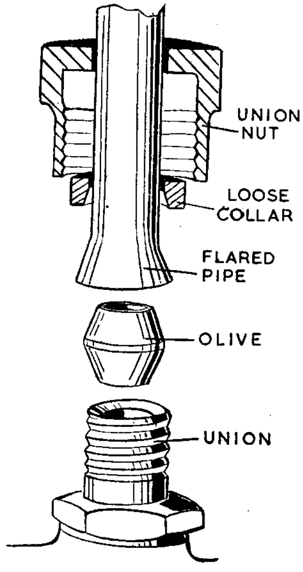


Fig. 7. A more complicated type of end fitting suitable for high-pressure pipes

the second end of the pipe, make sure that the union nuts are on the pipe and that they are the correct way round. For a good job, an "olive" should be interposed between the pipe and the union (Fig. 7) and the angles of the union, "Olive," and pipe bell, should match up accurately.

The type of end fitting shown at *B* in Fig. 5 must be fixed by brazing or soft-soldering. Generally, low-temperature brazing makes the best job, and it is quite easy to do provided sufficient heat can be obtained. Some form of blowlamp will be necessary, as a bunsen burner is not hot enough or convenient. The pipe and the nipple must be clean and the nipple must be a fairly loose fit. They should be supported on two bricks, as shown in Fig. 8, the bricks helping to conserve the heat.

A Simple Operation

Brazing metal such as "Melt Esi" which fuses at just over 620 deg. C., can be bought in strips, and if this is used with a suitable flux such as "Easy-Flo," the operation is very simple. While the parts are being heated, the flux should be applied around the joint on the end of a piece of brazing metal. After a minute or two, the brazing metal should melt and run down between the parts, making a perfect joint. To finish off, the joint should be cleaned with a wire brush and polished with fine emery cloth.

When making a soft-soldered joint, the same procedure is followed, paying special attention to cleanliness and making use of a good cored solder. If ordinary solder is used, the parts should be pre-tinned, and the solder applied with a suitable flux such as "Baker's Fluid."

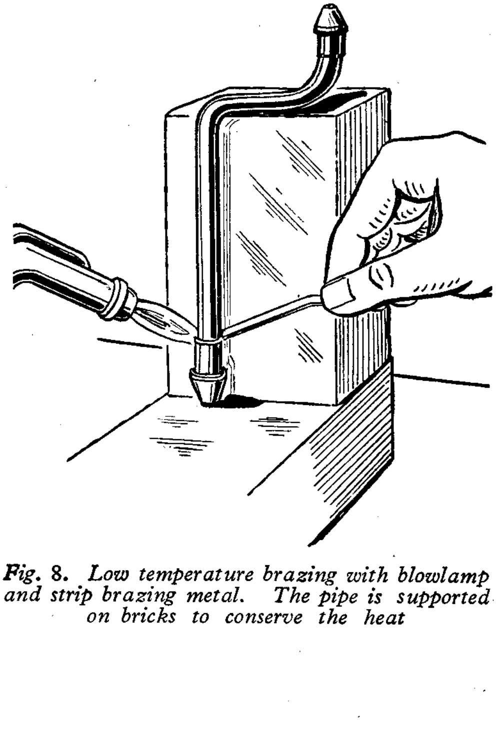
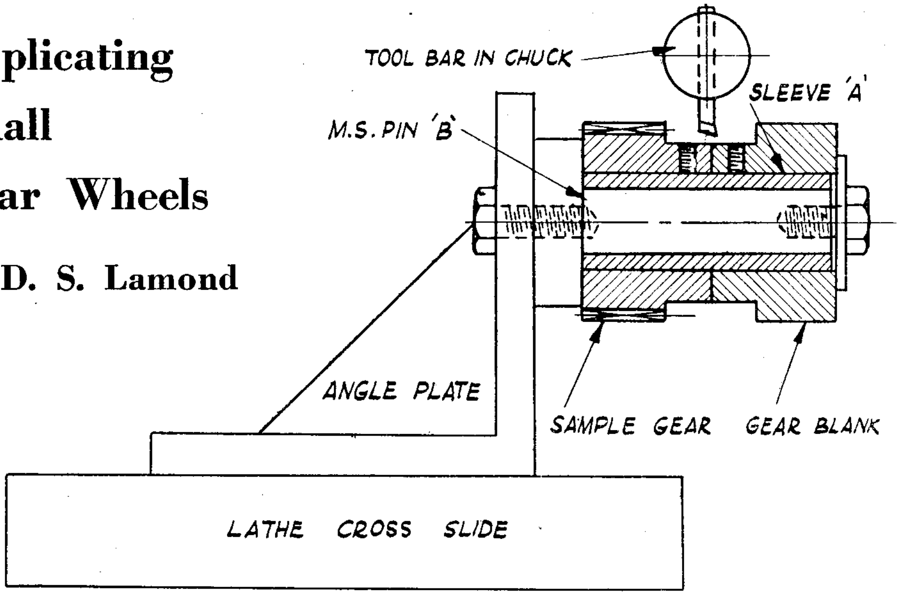


Fig. 8. Low temperature brazing with blowlamp and strip brazing metal. The pipe is supported on bricks to conserve the heat

Duplicating Small Gear Wheels

by D. S. Lamond



IN the course of my duties, it was found necessary to provide several small gears of 22 teeth, $\frac{3}{8}$-in. pitch. Deliveries nowadays being what they are, and no gear cutting equipment being available, it was decided to produce them on an 8-in. Willson lathe in the workshop.

A sample gear was available, and the method of using this for indexing may be of interest to model engineers.

The gear blanks were machined in the usual way, and as they were to be fixed by means of Allen screws, the screw holes were drilled and tapped in the bosses.

A M.S. sleeve "A" was then made, the outside diameter being a push fit in the bores of the gears. The length of the sleeve was 1/32 in. less than the combined lengths of two gears, so that the tightening washer would bear directly on the end gear. The bore of the sleeve was such that the sleeve could not be crushed when the Allen screws in the gears were reasonably tight.

A M.S. pin "B" was then turned up, as shown in the sketch, to a nice fit without shake in the bore of the sleeve and the same length. One end was left larger in diameter to provide a shoulder for the gears to butt against.

Each end of the pin was drilled up the centre and tapped for a set-screw.

The topslide of the lathe was removed and a small angle plate bolted to the cross slide, with the vertical face parallel to the centre-line of the lathe. This was easily accomplished by traversing the slide-rest with the angle plate past an indicator.

The pin "B" was fixed to the angle plate with the larger diameter butting against the face of the plate and secured by a set-pin through the angle plate into the tapped hole in the pin. The sleeve was then fitted on to the pin, and the sample gear with a blank on to the sleeve with the bosses together, against the shoulder of the pin, and secured to the sleeve by means of the Allen screws.

A set-pin and washer screwed into the tapped hole in the pin and tightened against the gear blank then held everything in position.

A piece of square H.S.S. was ground to conform to the shape of the space between the teeth of the sample gear. This was fixed in a tool-bar held in the lathe chuck.

The slide-rest was adjusted so that the cutter was central in relation to the gear blank and then locked.

By means of adjusting the height of the jig on the angle plate and tapping out the cutter so that the tip touched the bottom of the tooth space in the sample, the proper depth of cut was obtained.

The lathe was then started and the cross-feed applied.

When the cut was through, the slide was returned to the starting point, the set-pin and washer slackened off, and the sleeve, together with sample and blank turned the space of one tooth. The cutter was brought round and the position of the gear adjusted so that the cutter fitted accurately into the next space of the sample gear, the cutter itself acting as a detent.

The set-pin and washer was again tightened, and the procedure repeated until the complete blank was cut.

Several gears were produced in a short time, and those which are in service at the moment are giving every satisfaction.

Although the gears produced may be a bit large to be strictly a model engineering job, the method could easily be adapted to produce smaller gears, provided a sample is at hand. The sketch should make the arrangement clear.

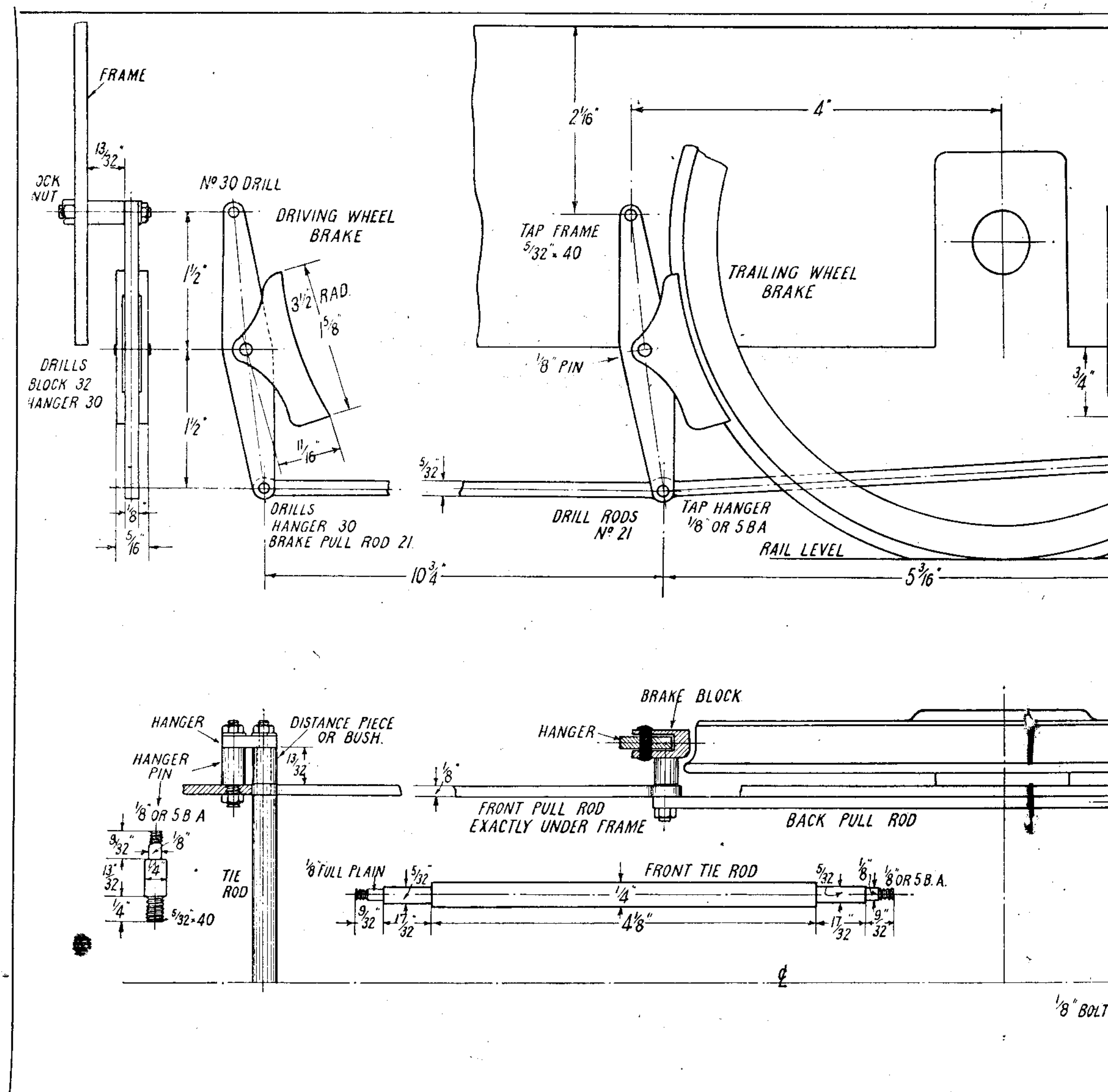
Steam Brake for " M

by "L.B.S.C

THE full-size sisters of the little " Maid " are fitted with vacuum brake apparatus, consisting of two 18-in vacuum cylinders operating at each end of a " Bill Massive " type of cross-shaft. The usual heavy flat brake beams are fitted, worked by centrally-disposed compensated pull-rods. The " Minx's " big relations are—or were—fitted with the Westinghouse brake, the pull-rods and beams being arranged in a similar manner, the cross-shaft being operated by the usual type of Westinghouse brake cylinder, with triple valve and auxiliary reservoir. Now, apart from the fact that I haven't specified either air or vacuum brake fitments, the very fact that both engines have dumping grates and ashpans, precludes the use of a brake gear of the type fitted to the full-sized engines ; therefore once again, we have to follow the procedure of a full-size C.M.E. and scheme out a brake suitable for the job in hand. The reproduced drawings show how a simple form of steam brake can be fitted, which will " comply

w
y

b
b
a
C



or " Maid of Kent "

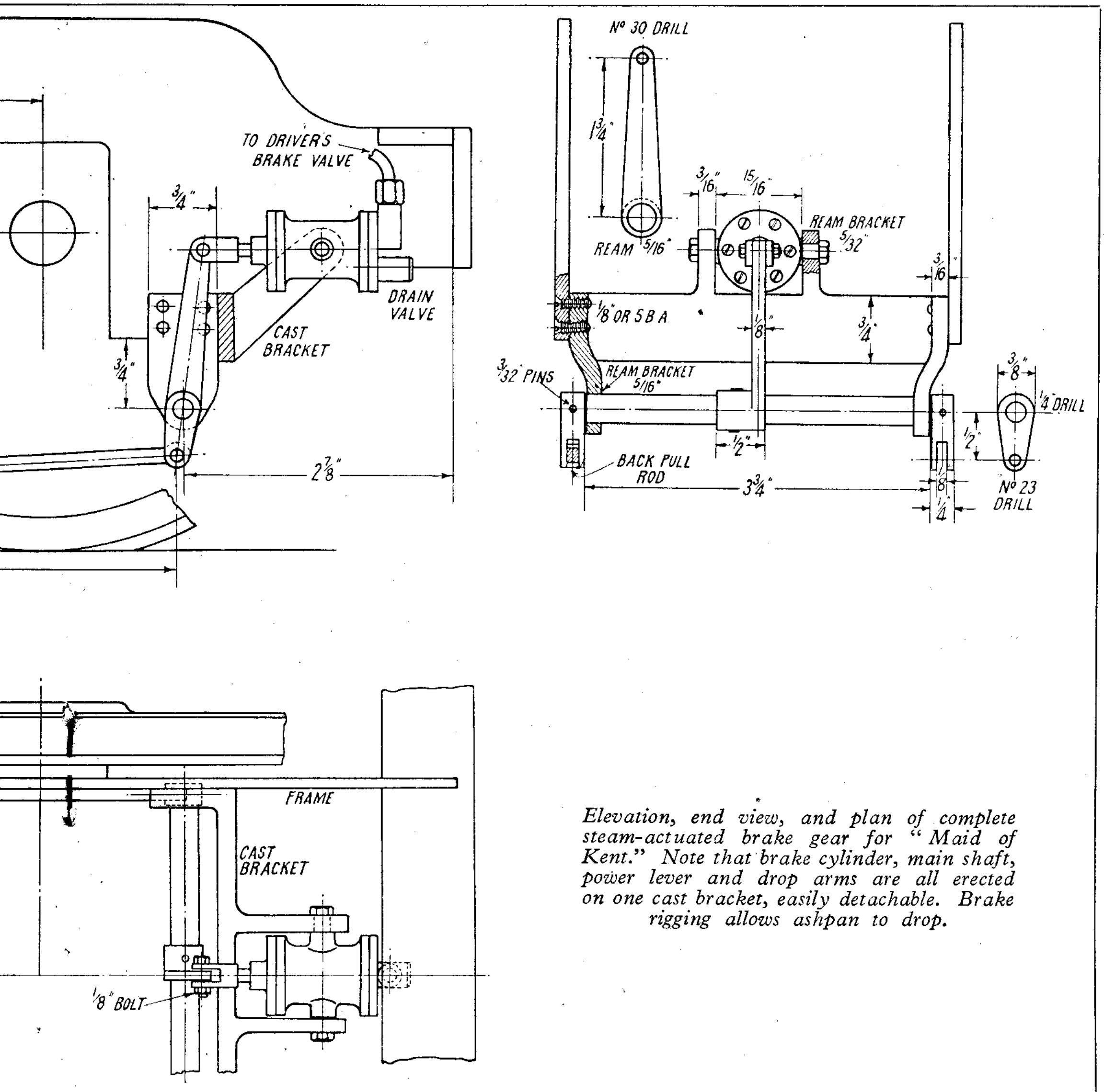
y " L.B.S.C."

with the conditions," in a manner of speaking, yet be effective.

The same general arrangement will do for both " Maid " and " Minx," the only variations being in detail, to suit the different wheel sizes, and the extra set of blocks on the " Minx." On the " L1 " class engines of the Southern, the brake cylinders and cross-shaft are supported by a cast sub-frame bolted to the inside of the main frame under the trailing end. On our little engine, we can use a casting to support the cross-shaft and the brake cylinder, making the whole actuating gear self-contained ; the cylinder, complete with pipe connection, also the cross-shaft with its power-lever, and drop arms and back pull-rods, can be erected on the casting, the whole bag of tricks placed in position in the frames, and secured by four screws at each side.

Brake Blocks and Hangers

It is probable that our advertisers who specialise in " approved " castings for " L.B.S.C."



Elevation, end view, and plan of complete steam-actuated brake gear for " Maid of Kent." Note that brake cylinder, main shaft, power lever and drop arms are all erected on one cast bracket, easily detachable. Brake rigging allows ashpan to drop.

engines, will be able to supply little cast-iron brake-blocks, and if so, they will only need a slot cutting in the back for the hanger, and drilling for the pin. If castings are not available, make the blocks from $\frac{7}{8}$-in. by $\frac{5}{16}$-in. mild-steel. If you have a milling machine, or the use of one (did I hear somebody murmur : " Now for a bit more homework " ?) the job of shaping the steel is just a piece of cake ; but if not, the only thing to do, is to get busy with saw and file. The blocks can be hacksawed roughly to shape, which will make the job easier and quicker than filing alone If a big faceplate is available, the blocks could be bolted or clipped to it at the correct distance from centre, and the radii put in with a boring tool, in a manner somewhat similar to the way described for making Joy guides for the slide shaft. The grooves in the back, failing a milling machine, can be cut with a $\frac{1}{8}$-in. end-mill or slot-drill in the three-jaw, with the block clamped on its side under the slide-rest tool holder ; or the block can be gripped in a machine-vice on the lathe saddle, at the correct height, and traversed under a cutter (saw-type, $\frac{1}{8}$ in. thick) on an arbor between centres. Use a high speed for the end-mill, and slow for the big cutter, but don't forget plenty of cutting oil, for free cutting in steel.

The hangers are very easily made, being milled or filed to the shape shown, from $\frac{1}{2}$-in. by $\frac{1}{8}$-in. mild-steel. The upper ends are drilled No. 30, ditto the middles, and the lower ends of the pair for the driving-wheel blocks ; but the lower ends of those for the trailing blocks, are tapped $\frac{1}{8}$ in. or 5-B.A., and pins turned from $\frac{1}{4}$-in. round steel screwed into them. For the pins, just chuck a piece of $\frac{1}{4}$-in. steel rod in three-jaw ; face the end, and turn down 7/16 in. full length to 5/32 in. diameter. Further reduce $\frac{3}{16}$ in. length to $\frac{1}{8}$ in. diameter, and screw $\frac{1}{8}$ in. or 5-B.A. Part off at $1\frac{1}{8}$ in. from the end ; reverse in chuck, turn down $\frac{1}{4}$ in. length to $\frac{1}{8}$ in. diameter, screw $\frac{1}{8}$ in. or 5-B.A., and assemble as shown. The brake blocks are secured to the hangers by pieces of $\frac{1}{8}$-in. round silver-steel, driven through the holes in the brake-block, the hanger being previously placed in the slot, with the pinhole lined up with its confreres in the block. Note—don't forget, when pinning the trailing blocks to the hangers, that you want one right and one left hand, so that the business side of the blocks is next the wheels ! The bottom pins, naturally, should point toward the centre-line of the engine.

Hanger Pins and Brake Rods

The hanger pins are turned from $\frac{1}{4}$-in. steel rod, same as the pins just described ; a good wheeze, to get the correct length of thread on the end which is partly plain, is to slip the hanger over it before screwing, and then run on the die until it touches the hanger. The tie-rod is another simple job, the ends being turned as described for bottom hanger pins, and a hanger being slipped on to determine length of thread. Two distance-pieces, or bushes, are needed, to keep the brake pull-rods parallel with centre line of engine ; these are merely 13/32-in. lengths parted off the $\frac{1}{4}$-in. rod. Chuck each in three-jaw ; centre, and drill through with No. 21 drill, facing off any burr left by drilling.

Mark off four points on the engine frames, 4 in. ahead of centre of axle, and $2\frac{1}{16}$ in. from the top of frame. Centre-pop each carefully, and drill them all No. 30 ; tap 5/32 in. by 40. Screw the 5/32-in. ends of the hanger pins into these holes. The front two can be locknutted as shown, but the rear two would need thin nuts to go between frame and firebox, and a special thin spanner to tighten them ; so if you make the threads a tight fit in the frames, so that they won't have a chance of working themselves out, it will be all right. When the hangers are erected, they should just be free to move fore and aft, but not sideways, when the nuts are screwed up tight. The blocks also, should not be able to flop about on the hangers ; they should be just free enough to adjust themselves to the wheel treads when the brakes are applied, but stiff enough to maintain that position when the brakes are off, and thus avoid rubbing on the wheel treads all the time the engine is running.

After the job of milling or filing the main coupling-rods, the brake pull-rods will seem like repeating the operation on a doll's locomotive, except that it would have a mighty long wheel-base. They can be cut from $\frac{1}{8}$-in. by $\frac{1}{4}$-in. mild-steel rod ; anybody who is lucky enough to own, or get the use of a milling-machine with a table movement long enough to mill the longer rods at one fell swoop, won't have any cause to worry. Most ordinary millers can easily manage the shorter ones. However, there is a way of making the pull-rods without any milling whatever, and precious little filing, if you can get hold of some 5/32-in. by $\frac{1}{8}$-in. section steel ; or $\frac{3}{16}$-in. by $\frac{1}{8}$-in. would do at a pinch, as the extra depth of the rods would not worry anybody except Inspector Meticulous. Form the eyes from $\frac{1}{8}$-in. by $\frac{1}{4}$-in. rod, or even from any odd bits of steel that might be left over from the frames. Leave a little tag on each eye, and file away half the thickness. File a corresponding rebate in the end of the straight bit of rod ; rivet together with a couple of bits of domestic pin, and braze the joint, using brass wire as brazing material, or Sifbronze it. Just apply some Boron compo paste, heat to bright red, and touch the joint with a bit of 16-gauge, or thinner, soft brass wire, which will melt and sweat in. If it doesn't, the job isn't hot enough ; some wire melts quicker than others. When the joint is cleaned up, the built-up rods are every bit as good as one-piece solid rods. They are always painted on full-sized engines, anyway ! See the eyes are drilled No. 21. Don't erect the rods until the actuating gear is ready, when the whole issue can be put up at the one go.

Cross-shaft and Bracket

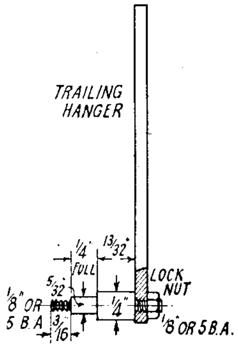
The bracket which supports the cross-shaft and brake cylinder is a good stout casting, which may either be iron or gunmetal. Very little machining is needed ; the only parts needing to be faced up truly, are the sides which come in contact with the frames, and the inside faces of the lugs carrying the brake cylinder. Failing a milling-machine, planer or shaper, the outer faces can be end-milled, same as axleboxes and similar parts, with the casting held under the slide-rest tool-holder, and traversed across an

end-mill or slot drill about $\frac{5}{8}$ in. in diameter, held in the three-jaw. If a vertical slide is available, the casting can be held in a machine-vice attached to same. Careful hand filing would also serve quite well, checking for squareness with a try-square. A few careful rubs with a file, on the inside of each of the lugs for holding the cylinder, would soon settle that part of the business. When setting out the location of the brake shaft and cylinder trunnion holes, here is a tip for beginners; old as the hills, but more often than not, entirely neglected. Mark off the position of the holes as shown in the drawing, centre-pop them, and then put the casting in the lathe between centres. If O.K., the casting will hang truly; you can tell just by looking at it. If it lops over to one side or the other, the holes are out, and the very position of the casting will indicate which way and how much correction is needed.

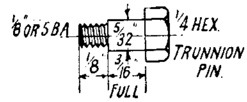
To drill, put the drill in the three-jaw, with the tailstock centre in the opposite pop-mark; feed up with the hand wheel on the tailstock barrel until the drill goes right through; then reverse, and put the tailstock centre in the previously drilled hole whilst you "ditto repeato." The holes must then, of necessity, be dead in line. Drill lugs No. 24 and shaft bearings 19/64 in.; ream 5/32 in. and $\frac{5}{16}$ in. respectively, putting the reamer through both holes of each size, at once.

On each side of the frame, just behind the trailing hornblock, drill four No. 30 holes and countersink them. This can be done between the spokes of the trailing wheels. There is no need to bother about "mike measurements"; drill the first hole about $\frac{1}{8}$ in. from bottom edge of frame, and about $1\frac{5}{16}$ in. behind the centre-line of the axle, the next $\frac{1}{4}$ in. above it, and two more, level with them, 7/16 in. to the rear, as the sergeant-major would say. Now set your bracket in the position shown in the illustration, with the shaft holes $2\frac{7}{8}$ in. from back end of frame (measure from inside of drag-beam) and $\frac{3}{4}$ in. below. Clamp temporarily in position, run the No. 30 drill through all the holes, making countersinks on the bracket, then take it out, drill the countersinks No. 40, and tap $\frac{1}{8}$ in. or 5-B.A.

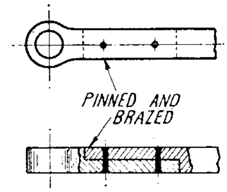
The cross-shaft is a piece of $\frac{5}{16}$-in. round steel faced off at each end to an overall length of $4\frac{1}{4}$ in. It carries a power lever and two drop arms. The former is filed up from an odd bit of frame steel, or a piece of $\frac{1}{8}$-in. strip steel of suitable width. Drill both ends No. 30 for a start; then chuck a piece of $\frac{1}{2}$-in. or 7/16-in. round steel in the three-jaw, and turn a pip on the end, a trifle over $\frac{1}{8}$ in. long, and a tight fit in the No. 30 hole. Part off at $\frac{3}{8}$ in. from the shoulder. Squeeze the pip into the hole in the large end of the lever, and braze it, as mentioned above. Chuck the boss in the three-jaw, centre, drill right through with 19/64-in. drill, and ream $\frac{5}{16}$ in. Clean up the whole lot, and you have a nobby lever.



Trailing hanger and pin

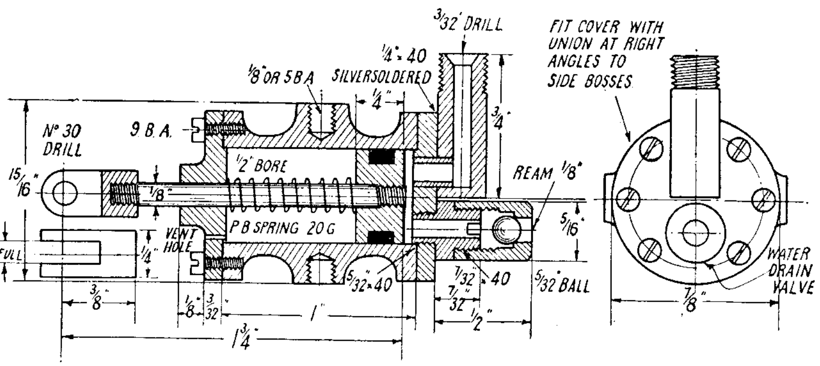


Trunnion pin for brake cylinder



End of built-up pull-rod

The drop-arms are made from $\frac{1}{4}$-in. by $\frac{3}{8}$-in. bar. Cut a piece long enough to hold in your machine-vice, or under the slide-rest tool holder; cut a slot in each end, $\frac{1}{8}$ in. wide and about $\frac{5}{16}$ in. deep, as described for valve-gear forks. Saw off the slotted ends, to a length of 15/16 in., and file or mill to the shape shown. Drill the larger end $\frac{1}{4}$ in., and the small one No. 23. If



Section of brake cylinder

you haven't a drilling-machine, use the lathe, chucking in four-jaw and adjusting until the centre-pops run truly, then drilling from the back centre with a drill in the tailstock chuck, as the holes must go through truly.

Turn down $\frac{1}{4}$ in. of each end of the cross-shaft, to a tight squeeze fit in the holes in the drop-arms, and squeeze one on. Put the shaft through the bracket, putting the power lever on as it passes

through, then squeeze the other drop-arm on. Both drop-arms should be in line, and the power lever dead opposite at 180 deg., as seen in the elevation view. Don't pin the arms yet, as some slight adjustment may be called for when erecting, to get all blocks contacting the wheels at once; make it the last job.

Brake Cylinder

Making the brake cylinder is a bit of a cake-walk after machining the engine's own cylinders. Although the casting is circular, you can't hold it for boring in the three-jaw, on account of the trunnion bosses getting in the way, so the only thing to do, is use the four-jaw, and set it to run truly. Face off the flange, then bore out with an ordinary boring tool until the "lead" end of a ½-in. parallel reamer will just enter; then poke the reamer through, non-stop each way, holding the reamer against the tailstock centre, and preventing it turning, by a tapwrench or lathe carrier clamped on the shank. Face the other flange with the cylinder mounted on a stub mandrel in the three-jaw. No ports to cut, thank goodness, says you!

No special instructions are needed for turning the covers, as they are treated to a dose of the same medicine as the big covers. No gland is required. The piston is roughed out from a bit of 9/16-in. or ⅝-in. drawn bronze rod, parted off to ¼ in length, drilled right through No. 40, opened out to ⅛ in. depth with No. 31 drill, and the other ⅛ in. tapped ⅛ in. or 5-B.A. The piston rod is a 1½-in. length of ⅛-in. ground rustless steel, screwed at each end for ⅛ in. length. Screw right home in the piston, and turn to fit the bore, by the same operations as described for the big cylinders The two bosses are drilled No. 40 and tapped ⅛ in. or 5-B.A. for the trunnion pins. The easiest way to face them, is with a pin-drill in the drilling-machine; a mere touch of the pin drill is sufficient to cut a true face on the boss. Face them before tapping.

The plain cover carries an automatic drain valve, to get rid of any condensate water which would otherwise fill the steam pipe right to the driver's valve; and a connection, with union screw, for the steam pipe. The drain is simply a little snifting valve on its side. The cap contains the ball valve and seating. To make it, just chuck a bit of $\frac{5}{16}$-in. round brass rod in three-jaw; face, centre, and drill down about ½ in. with No. 34 drill. Open out to ¼ in. depth with $\frac{3}{16}$-in. drill, and bottom with $\frac{3}{16}$-in. D-bit to $\frac{5}{16}$ in. depth. Tap 7/32 in. by 40, stopping clear of the ball seat, and part off at a bare 7/16 in. from the end. Reverse in chuck, and put a ⅛-in. reamer through. Chuck the rod again, centre and drill 3/32 in. for 7/16 in. depth; turn down 5/32 in. of the end to 7/32 in. diameter, screw 7/32 in. by 40, and part off ⅜ in. from the end. Reverse in chuck, turn down 5/32 in. of the other end to 5/32 in. diameter, screw 5/32 in. by 40, then seat a 5/32-in. rustless steel ball on the hole, and assemble as shown. Drill a No. 30 hole in the cover, level with cylinder wall, tap it 5/32 in. by 40, and screw the valve in. The ball is normally off the seating, letting water drain freely away; as soon as the driver operates his valve, any water remaining in the cylinder is blown out, and the valve flops on the seating.

To make the union fitting, chuck a bit of ¼-in. round brass rod in three-jaw. Face the end, centre deeply, drill down 11/16 in. depth with 3/32-in. drill, screw the end ¼ in. by 40, and part off ⅞ in. from the end. Drill a No. 23 hole ⅛ in. from the blind end, breaking into the central hole, and fit a stub of 5/32-in. copper tube in it. Drill a similar hole in the cylinder cover, and fit the projecting end of the tube into it; silver-solder the joint, temporarily removing the drain valve whilst doing the job. Attach the cover to the cylinder by six 9-B.A. screws, drilling the cover No. 48, and set it so that when the union fitting is vertical, the bosses at the side are horizontal, and at right-angles to it. Pack the piston with a few strands of graphited yarn, enter it in the cylinder, put a spring of 20-gauge phosphor-bronze hard-drawn wire over the rod, and fit the cover. No gasket is needed for this end; don't forget to drill an air vent. The trunnion pins are turned from ¼-in. hexagon steel rod, to dimensions shown, by the method described for hanger pins. The fork is made from a bit of ¼-in. square rod, and needs no detailing.

How to Assemble and Erect the Brake Gear

Put the cylinder between the lugs on the bracket, and screw the two trunnions into the bosses on the cylinder. It should just be free enough to oscillate slightly. Connect the fork to the power lever by a bolt or pin made from a bit of ⅛-in. round silver-steel, shouldered down to 3/32 in. each end, screwed 3/32 in. or 7-B.A. and furnished with ordinary commercial nuts. Note—when the nuts are screwed up quite tight against the shoulders, it should be possible to twist the pin with your fingers; this avoids the fork nipping the lever and preventing free movement. Now put a short brake rod in the slot of each drop-arm, and pin it by squeezing a bit of 5/32-in. round silver-steel through the lot; it should be tight in the drop-arm, but a working fit in the eye of the rod. File flush each side. Now hoist the whole bag of tricks in place, and line up the screw-holes in the sides of the bracket, with the holes in frame; then secure with four countersunk screws each side.

Next, put one end of each long pull-rod over the ends of the tie-rod which is to connect the front hangers; put on the distance pieces, and then put the rod in place, with the extreme ends passing through the bottom holes in the hangers, as shown in plan view. When the nuts are screwed to the ends of the threads, the hangers should just be free to move on the rod. If you have any difficulty in getting the ends of the tie-rod through the hangers, simply take the latter right off; then hold the tie-rod in place, and put the hanger back, sliding it over the end of the tie-rod and the hanger pin, at the same time. Take off the trailing hangers; line up the two pull-rods as shown in plan view, front one outside, and replace the hangers with the bottom pin passing through both eyes. Secure with commercial nuts; adjust arms and pin them, and Bob's your uncle. You now have a working steam brake gear which is entirely clear of the ashpan, allowing same to be dumped.

*Traction Engines not so Well Known

by Ronald H. Clark, A.M.I.Mech.E.

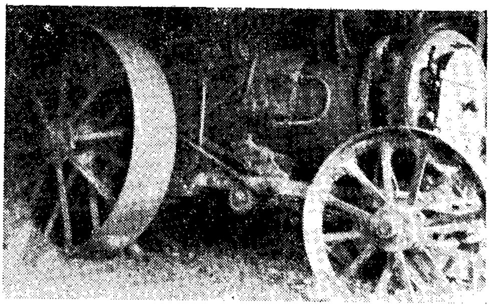


Fig. 7. John Collings' No. 1 chain engine of 1900

IV—John M. Collings, Bacton, Norfolk

A small firm employing probably less than a dozen hands under the control of the designer-manufacturer, John Maris Collings himself, who has a small works and foundry within the precincts of Bacton Hall. Although a number of ingenious agricultural implements were turned out as a stock line, three tractions were made all having some very interesting features. No. 1 was a small machine with duplex cylinders, $3\frac{1}{2}$ in. $\times$ 6 in., shown in Fig. 7. Unlike the conventional traction engine, the cylinders were placed, as in the early days, over the firebox. The valve-chests were placed outside for accessibility, with Stephenson's link-motion for each valve. The crankshaft, $1\frac{5}{8}$ in. diameter, has the two-speed gears incorporating a dog-clutch outside the bearing on the nearside, the countershaft running beneath the boiler with the final chain drive sprocket of five teeth on the offside end, all seen in Fig. 7. The rear axle sprocket contains the differential within it, the chain being $3\frac{1}{2}$ in. pitch $\times$ $1\frac{1}{2}$ in. between side-plates. The six-spoked flywheel 2 ft. $7\frac{1}{2}$ in. diameter $\times$ 4 in. face is mounted on the extreme nearside end of the crankshaft and outside the gearing. Rear wheels are 4 ft. diameter $\times$ 11 in. tread, and front 2 ft. 8 in. diameter $\times$ 5 in. tread. One Salter safety-valve was mounted on the side of the firebox. Most of the castings for this little engine were made by the now-defunct firm of G. S. Soame of Marsham, Norfolk, themselves makers of the first steam engine specifically designed to drive a roundabout. An uncommon example of a chain engine, light in weight and designed and made in 1900 to do the work now performed by a medium petrol-paraffin tractor.

The other two traction engines made by Collings are very interesting, being of the tandem single-crank compound form with cylinders 5 in. and 8 in. $\times$ 10 in. taking steam at 250 p.s.i., the safety-valve being set to blow off at 260 p.s.i. Steam was supplied from locomotive-type boilers made specially for him by Messrs. Alfred Dodman & Co. Ltd., Highgate Works, Kings Lynn. Fig. 8 shows one of these engines at work, pulling, by direct traction, two combined reapers and binders for which type of work they were designed to be as light and as powerful as possible. Both these compounds and the chain engine are yet preserved at Bacton.

V—The Cooper Steam Digger Co. Ltd., Steel Works, Kings Lynn

Originally established by the late Thomas Cooper, a little prior to 1900, for the purpose of manufacturing his patent steam digger. Thomas Cooper was previously managing director of the Farmer's Foundry Co. Ltd., of Great Ryburgh,

*Continued from page 766, Vol. 100, "M.E.," June 23, 1949.

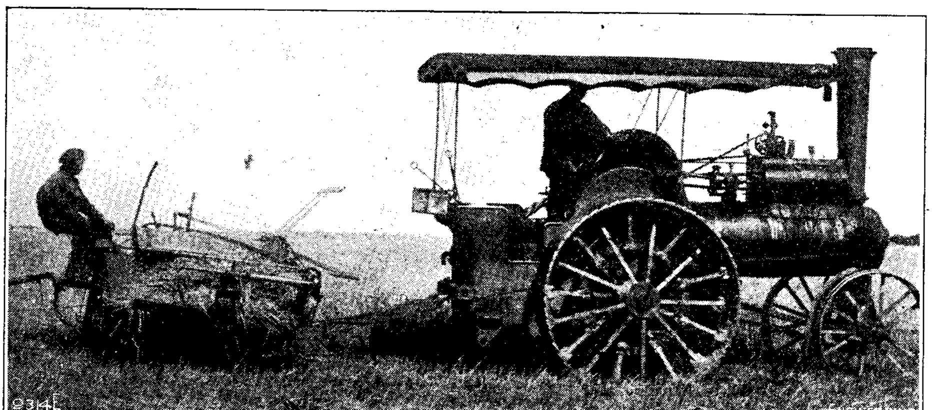


Fig. 8. Tandem compound engine by John Collings, of Bacton

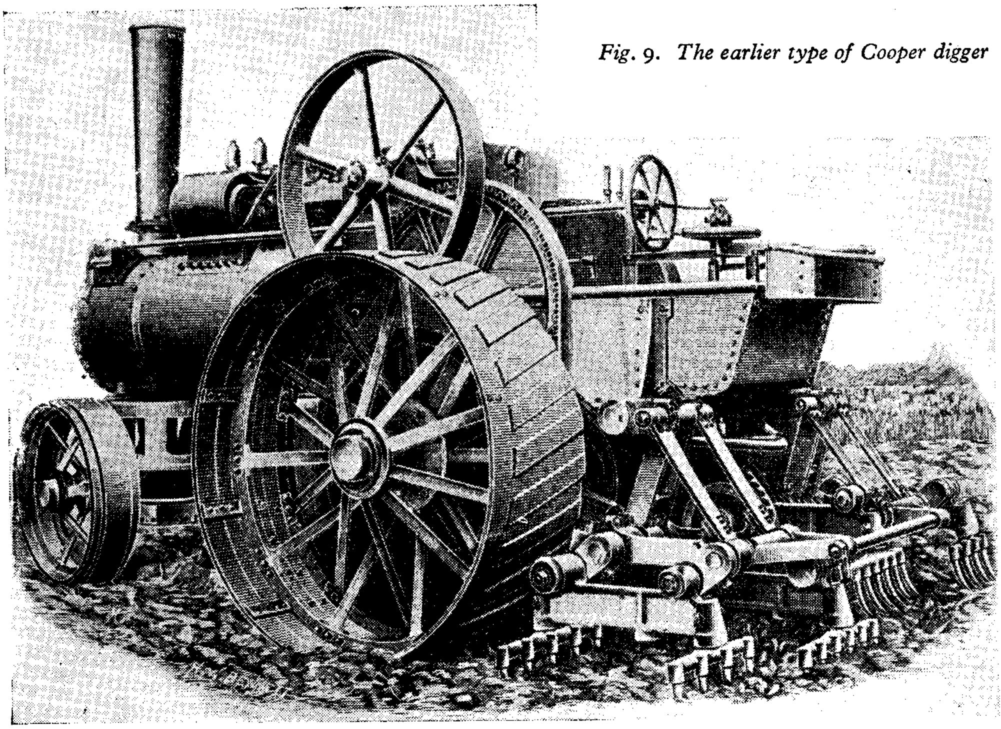


Fig. 9. The earlier type of Cooper digger

Norfolk, which he left to start on his own at Lynn. He was also responsible for a patent split roller-bearing made in the works at Lynn, and after his demise the concern became the Cooper Roller Bearings Co. Ltd., under which title it still exists.

The earlier Cooper Diggers utilised an over-type traction engine with the digging frame attached behind as shown in Fig. 9. The mechanics of the digging frame was ingenious and may be briefly described as follows: the action of digging was done by forks which were placed in two rows 2 ft. apart across the line of travel of the engine. Each row of forks is composed of four groups of equidistant prongs and each group forms a digging unit. In all, there are five prongs in each separate digging group of the front and back rows, totalling 40 prongs in all. The prongs in the first row are chisel-shaped and those in the second row are curved, being designed to break up the lumps dug by the first row. The cross-shafts carrying the groups of forks are driven by gearing from the rear axle of the traction engine, so that the forks have imparted to them a continuous circular motion and the depth of digging could be varied from 3 in. to 8 in. The variable depth of digging was accomplished by lifting the whole digging frame about the cross-shaft as a centre by an hydraulic cylinder fixed to the frame of the engine and operated by the boiler feed-pump. When not in use, or travelling on the road, the frame was elevated well clear of the ground.

In 1900, this form of digger was tested in trials at York by the late Prof. W. E. Dalby for the Royal Agricultural Society, from which test it was ascertained that 32.04 i.h.p. was developed in digging light and 40.09 when digging heavy soils, the number of sq. yd. worked per i.h.p. per hour being 147 and 109 respectively. The main dimensions of the engine were: Compound cylinders 6½ in. and 11½ in. × 12 in. w.p., 150 p.s.i. Total weight of digger and engine 11 ton 18 cwt. 2 qtr. Price £750.

A still larger digger rated at 12 n.h.p. was also produced at this period having compound cylinders 8 in. and 13 in. × 12 in. using steam at 170 p.s.i. The barrels of the boilers of these larger engines were short in length and of large diameter, the firebox being of ample size and having a raised top. Riveted to the outside casing plates were two ½-in. hornplates extending rear-wards and between these was fitted a ⅝ in. flat plate forming the top of the water tank and a fixing for the engine itself. Note that this was mounted behind the manstand, with the crank-shaft direct over the digging gear and the counter-shaft over the top of the rear axle with the two-speed gear wheels and the compensating gear mounted on it, the traction engine portion being double-geared on the last motion. A general view of one of these engines is seen in Fig. 10. It is very interesting to note, in passing, that in this layout with the engine mounted in the tender, the designer had reverted to the scheme evolved in the Howard "Farmer's Engine" as far back as 1877 and to be described later.

Shortly after 1900, Thomas Cooper designed and brought out his "No. 5" Digger, and here he employed four forks each fitted with three

renewable prongs or tines worked at 150/200 r.p.m., the engine turning over 250/300 r.p.m., a view on the digging gear being shown in Fig. 11. The total width dug was 5 ft. 10 in. and when digging light land, like that met with on the West Norfolk "Brecks," extensions could be fitted bringing the total width dug up to 6 ft. 10 in. and four to six acres could be dug per day.

If cable ploughing was desired, then the engine could be supplied and equipped as depicted in Fig. 12, with either double or single drums. The double drum enabled single engine tackle to be used, but the single drum system, of course, required two engines, one on each headland. All parts of the "No. 5" Digger were interchangeable, the cranks, connecting-rods, crossheads and valve-gear all working in an oilbath. The maximum depth dug with the digger was 9 in. and a hand lever was provided for raising the digging gear and gradually lowering it into the ground. With cable ploughing, furrows up to 20 in. deep could be drawn in normal ground.

The main dimensions of the "No. 5" traction engine itself (they were, of course, supplied as engines only) are as follow: Compound cylinders $4\frac{3}{4}$ in. and 8 in. $\times$ 9 in., w.p. 180 p.s.i.; patent boiler containing 50 tubes $\times$ $1\frac{5}{8}$ in. diameter. Total heating surface 85 sq. ft., e.h.p. = 25. Tank capacity 120 gallons. Coal, 6 cwts. Road speed up to 6 m.p.h. Other refinements included gears of crucible cast steel, automatic band brakes to the drums, guide pulleys beneath the boiler and the engine could be turned round in its own length in 30 seconds. Several of these engines were exported to Egypt and the Near East.

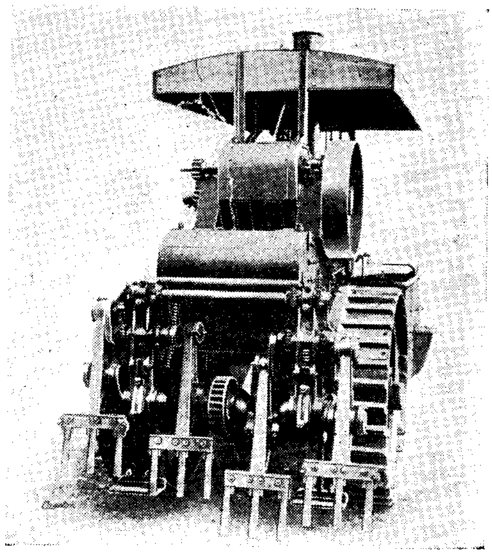


Fig. 11. View on digging gear of the No. 5 Cooper digger

VI—Davey, Paxman & Co. Ltd., Standard Ironworks, Colchester

A firm which took up the manufacture of road engines only after the turn of the last century and turned out a very good-looking engine seen in Fig. 13. The standard range comprised single-cylinder machines, and the schedule of powers and dimensions are given in Table III. The four-shaft principle is used and some interesting features are: a planed steel seat for the cylinder

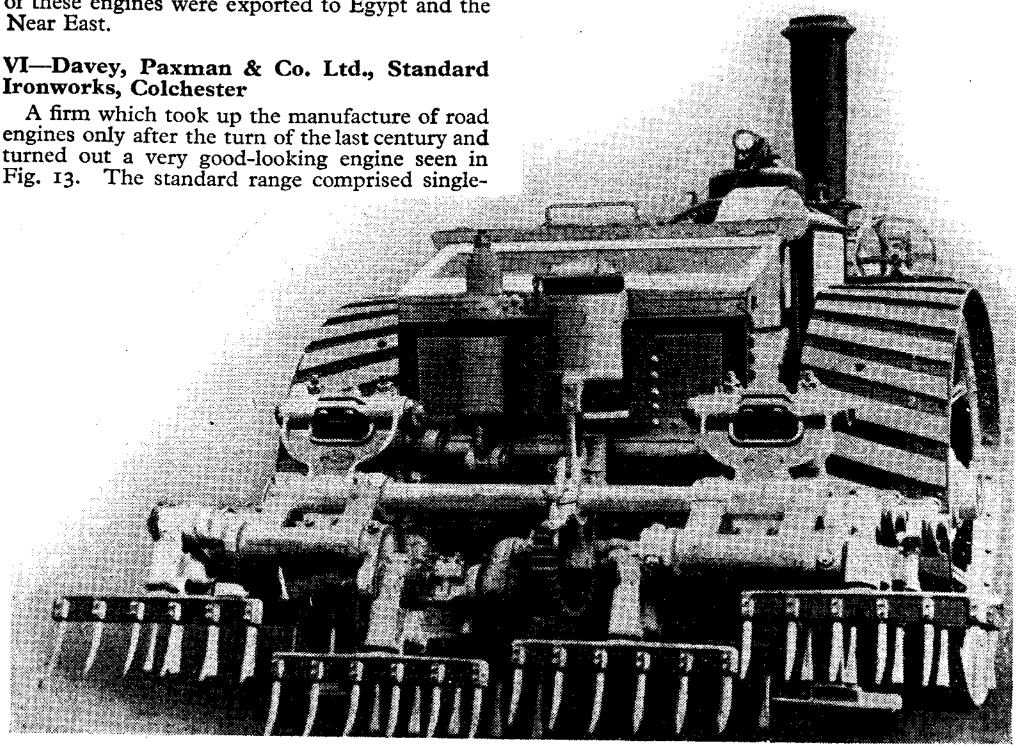


Fig. 10. Heavy type of Cooper digger

riveted to the boiler shell ; trick slide-valve ; castellated nuts and split pins for fixing the bearing brackets to the hornplates ; cast steel gearing from machine cut patterns and countershaft made square, where necessary, to accommodate the change-speed pinions.

Steam tractors of the three-shaft type having single or compound cylinders could be supplied to order, the single-cylinder engine being 6 in. bore × 9 in. stroke and designed for an unladen weight of under 5 tons. When driving by belt, the speed was high—300 r.p.m. with a flywheel 2 ft. 8 in. dia.

Special engines comprised a straw-burning traction with extra large firebox and funnel with spark catcher ; also a very unusual feature, viz : the flywheel on the right-hand side. The w.p. was 150 p.s.i. Another special engine was a fine heavy-duty road locomotive of the double-crank compound form, the main dimensions being : Cylinders 6 in. and 10½ in. × 12 in. w.p. 180 p.s.i. R.p.m. 180. Flywheel 4 ft. diameter. Driving-wheels 6 ft. 6 in. diameter × 18 in. wide. Leading wheels 4 ft. diameter. Speeds 3 and 5 m.p.h. Weight empty, 11 tons.

The cylinders are arranged with the trick valves between them and, with such an arrangement, refacing the port faces is not an easy matter as many apprentices in country repair shops have found out.

(*To be continued*)

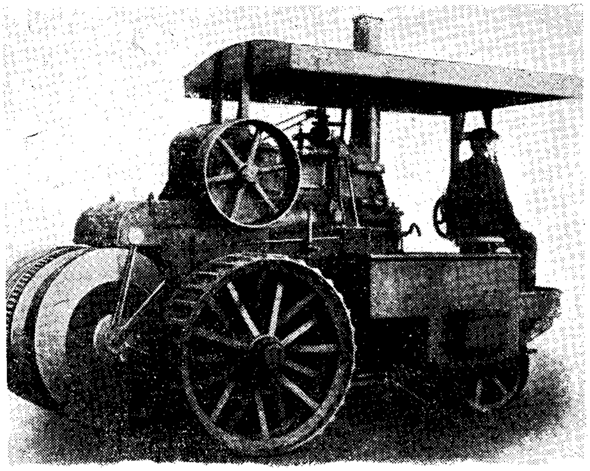


Fig. 12. *The No. 5 Cooper digger arranged as a cable ploughing and traction engine*

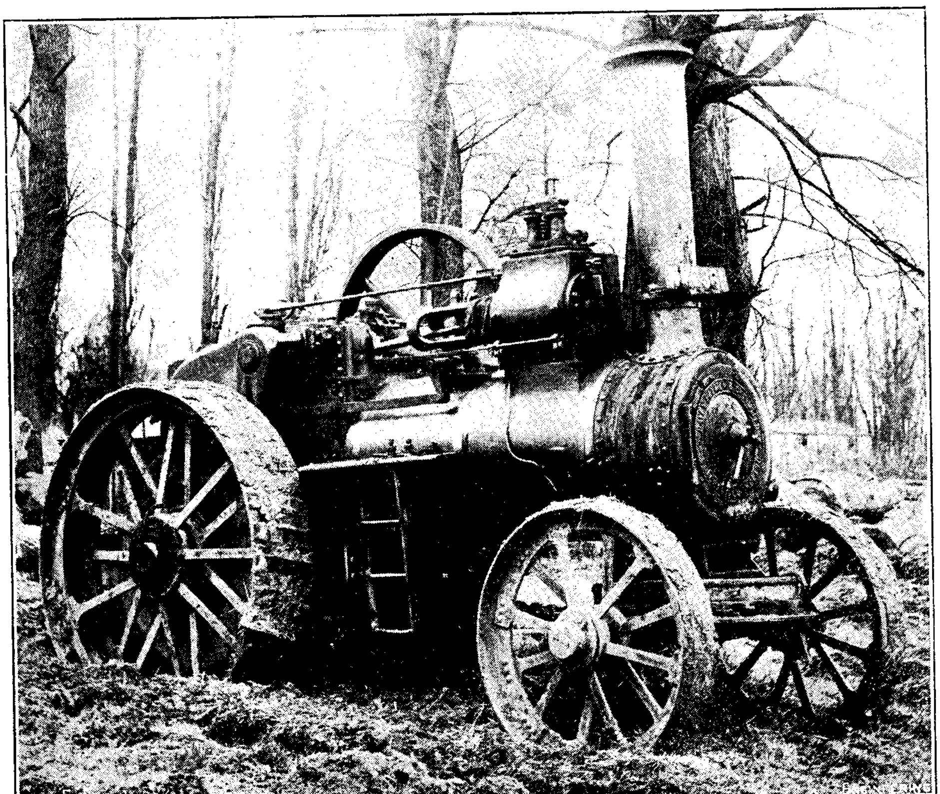
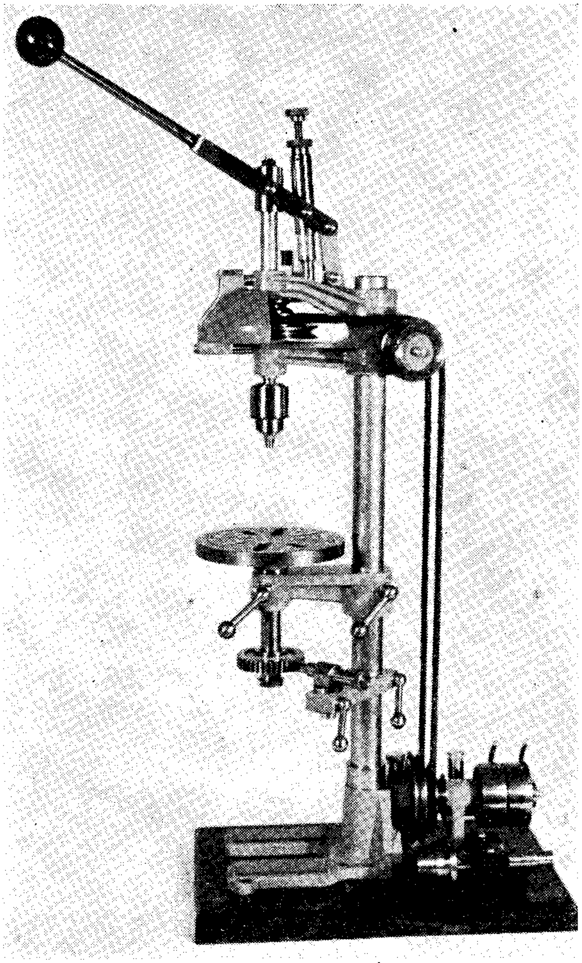


Fig. 13. *Single-cylinder four-shaft engine by Davey Paxman & Co. Ltd.*

Drilling Machine Modifications

by H. E. S. Chase

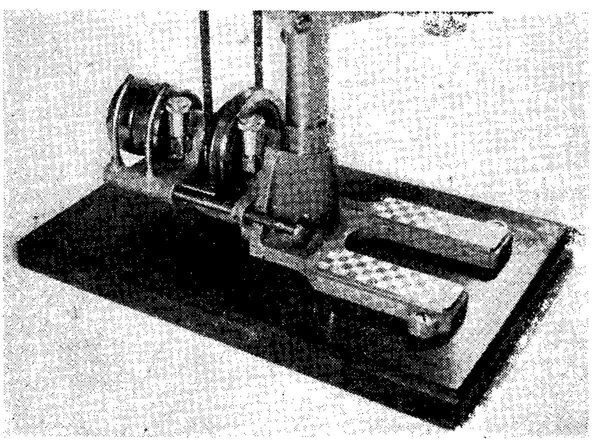


The modified "M.E." drilling machine

I HAVE recently finished building an "M.E." drilling machine, incorporating several modifications which have already been published in THE MODEL ENGINEER and also a few minor additions of my own. Despite the number of these machines which must have been built by now, I am submitting this description and photographs in the hope that many readers will find some interest in hearing of yet another addition to the large family.

The headstock countershaft, bracket, jockey pulleys and loose pulley are all bronze-bushed. In order to obtain a close working fit, the pillar and stem of drill table, also the corresponding bores of the headstock and swivel arms are finished by lapping. This treatment has also been applied to the drill spindle indexing plunger and the bore in which it works.

The pillar was turned from $1\frac{1}{8}$-in. round steel bar, prior to lapping. To avoid possible risk of splitting the soleplate casting by pressing in the pillar, and to ensure that the latter was positively secured, it was reduced to $\frac{3}{4}$ in. diameter at its lower end, the soleplate also being bored $\frac{3}{4}$ in. diameter to fit, and the shoulder of the pillar was drawn down against the soleplate by means of a $\frac{3}{8}$-in sunk set-screw in the bottom of the pillar. The distance-piece on the top of the soleplate is primarily to prevent the possibility of the lower swivel arm fouling the countershaft lubricators.



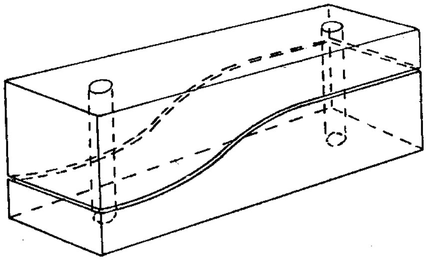
Soleplate, showing double rod striker control, and repositioned countershaft lubricators

The first attempt at beating the oil container portion of the belt guard from 16-gauge copper was a complete failure, but a second attempt was made using two wooden formers, with locating pegs passing through both formers and also the copper sheet, as indicated in the rough sketch, and the job then became simplicity itself.

The drill table, turned from a rather massive V-pulley casting, is slightly oversize ($4\frac{1}{2}$ in. diameter) and has been left thicker than specified to compensate for any weakness that might possibly result from increasing the number of slots in the table from four to eight.

A double rod is used for the striker control, to improve rigidity and dispense with the necessity for a square hole in the countershaft bracket. Oil is fed from the countershaft wick-feed lubricator to the sides of the bearings, away from the point of highest pressure at the top of the bearings.

In conformity with the general "motif" for the lubricators, knurled-headed brass plugs are

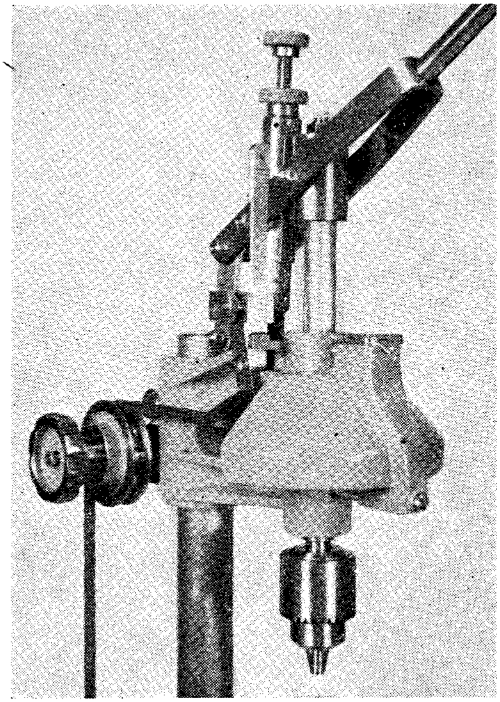


Wooden formers with steel locating pegs, used when beating oil-container portion of belt guard

fitted to the oilways in the drill and jockey spindles and countershaft. To avoid the possibility of the headstock clamping-nut fouling the jockey pulley when the belt is in the high-speed position, the end of the draw-bar was tapped and the nut replaced by an Allen screw having a disc $\frac{1}{2}$ in. diameter by 3/32 in. thick silver-soldered to the head.

Although the clamping pressure is limited to that obtainable by the $\frac{1}{8}$-in. Allen key, this has proved quite adequate, due probably to the close lap finish of the headstock bore and pillar. The adjustable depth-gauge is so positioned that the pointer may be attached to one of the thrust block pivot-screws which are non-rotary. The measuring scale is made from a piece cut from a 6-in. Chesterman rule.

In reading of other contributors' model engineering activities, I find added interest in learning the details of their workshop equipment,



Headstock, showing adjustable depth-gauge

and in view of this I would mention that my own equipment comprises a $3\frac{1}{2}$-in. Myford M.L.4 with standard accessories, plus steadies and vertical slide, and sundry home-produced items.

In these activities, economy has to be closely studied, but this in no way detracts from the interest. Among items constructed, I may mention a dividing-head, milling spindle, flexible-shaft grinder, a lathe filing rest, knurling tools, and last but not least, the drilling machine here described.

In conclusion, I would like to express my appreciation of the way in which THE MODEL ENGINEER has lighted the way for many amateurs, including myself.

The Darwen Society Revived

We were pleased to receive news from Mr. W. E. Baxendale that, after a lapse of more than ten years, the Darwen Society of Model and Experimental Engineers has just been revived. The co-operation of the local Education Divisional Executive of the Lancashire County Council has been secured, and a special model engineering class has been formed for the summer session at the Technical Institute workshop which is fully equipped with machine tools all in first-class order.

Members are allowed to make their own work, subject to a system of turns for each succeeding week on the machines. Mr. Baxendale adds: "Advice and help are available from the instructor and from one or two professional engineers, as well as from two or three of us who are old hands at the game. Several of the raw recruits are tackling the 'M.E.' drilling-machine, two are making simple stationary engines, whilst the more experienced are on with bigger jobs, making use of the better equipment to get through quicker, easier and, we hope, more accurately than at home. Picking out suitable jobs to be started and completed in an evening's session is a fine art."

*TWIN SISTERS

by J. I. Austen-Walton

Two 5-in. gauge locomotives, exactly alike externally, but very different internally

THE story of the wheels is by no means finished, and I feel that at least an account of my own experiences in the fitting of the shrunk-on tyres, will do much to dispel fears of this being a job much beyond the average man. To the contrary, it turned out to be simplicity itself, and I fail to see why this admirable practice has not been used more extensively in the past.

It will be seen on the drawing that gives an enlarged scrap section of the wheel, that a double step is made on both wheel and tyre, and, in my case, these steps were turned on the wheels first, and the tyre blanks afterwards.

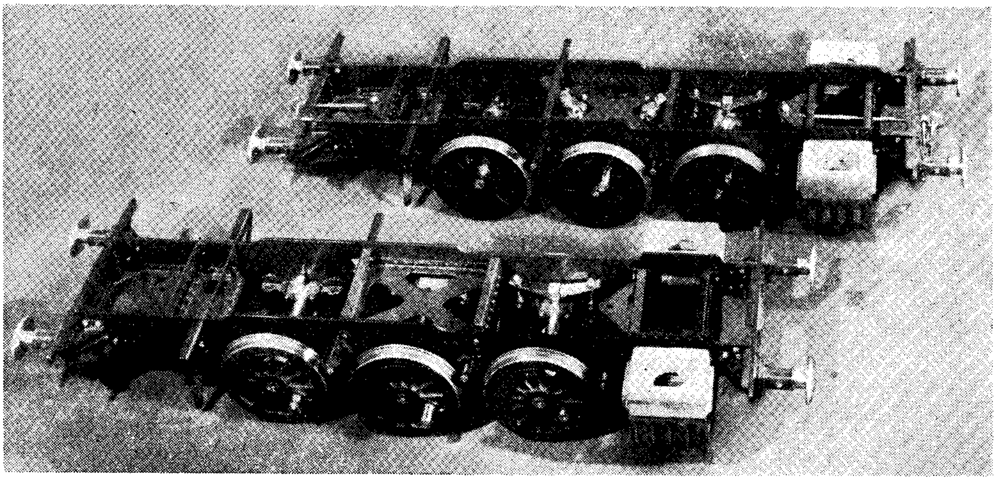


Photo by] [*A. Duncan*

They really are " Twin Sisters "!

This is not a case where you can machine until the mating parts almost fit, and I found, quite accidentally, that a normal shrink allowance of a full thousandth for ordinary mild-steel, was not really enough for the particular brand of stainless steel I happened to be using. This, by the way, was Messrs. Firth's E.M.S. procured in the " slice off the bar " form, and it has machining properties that shame even the best quality mild-steel. Anyone who can find fault with this particular grade of steel must indeed be hard to please.

I was not to know that a full two thousandth interference would have filled the bill completely, but as I managed a good sound job, I have learned something as well. To get the desired fit calls for measuring the male part, or the wheel, very accurately with a large micrometer or vernier caliper. A good quality caliper can be read to one thousandth with the greatest ease, and those fortunate enough to own such a tool can use it to measure the bore of the steel tyre as well.

If you have only a micrometer for measuring outside diameters, you will have to make a simple gauge, and this can be done by turning down a disc of any metal until it " mikes " one thousandth less in diameter than the wheel diameter. Boring out the tyre can then proceed until the disc gauge will just enter the bore of the tyre. If stainless steel were being used, this dimension would be *two* thousandths less.

Having machined my wheels and tyres to the calculated sizes, the tyres, not fully machined on the outside, were propped up on pieces of metal packing on the top of a heavy iron plate, so as to lie flat and with the mouth or entry uppermost, and a large gas/air blowlamp brought to bear. I had the wheels all ready and, when the first tyre had passed the blue-black colour, and had just a suggestion of turning to a very dull red, a wheel was picked up with pliers by one of the spokes and lowered into the tyre.

Then came the first shock and surprise, for the wheel rattled round in the hot tyre like the proverbial pea in a drum. It was not long before the wheel took up some of the heat, and in a few seconds, all audible shake had disappeared.

Here I suspended operations until the first wheel had cooled down, and I was pleasantly surprised to find the tyre shrunk hard on the

*Continued from page 698, Vol. 100, " M.E.," June 9, 1949.

wheel. I further established the state of hold by subjecting the wheel to some pretty brutal treatment, but, to all intents and purposes the two parts were welded together.

This cleared the field for the remaining five wheels, and I studied the shrinking and visible clearances when hot, with more interest and much less alarm. I still wanted to have a "make-sure" job, and I reckoned that in certain circumstances where the wheel might again be made hot that movement of the tyre could possibly develop.

The enlarged scrap section, showing the insertion of three security grubscrews, equally spaced round the tyre-to-wheel junction line, explains a step I took to ensure that such an unfortunate happening would not produce these results some time in the future. I have noticed, more than once, that stainless steel, in most of the commercial grades obtainable, is rather lively on the expansion business, and it is a tendency that is worth keeping well in mind.

To finalise on this job, it remains for me to add that the finished turning of the tyre to the correct dimensions and profile, still using the turning spigot mentioned earlier on, was quite a normal operation. We now come to the fitting of the balanceweights where these are used in preference to the all-cast wheel. The drawing shows the crescent plates marked out for the two wheels, together with some simple spacers to go between each pair of plates, and arranged to miss the spokes of the wheel. It is rather essential to get the plates to lie flat on the wheel spokes, and this may entail some chipping and filing to produce a suitable bed.

If you are not sure of your workmanship and would prefer a chance of cleaning up the front face of each balanceweight, after the rivets have been hardened up, then make the front or outer balanceweights in a heavier material, say 3/32 in. instead of $\frac{1}{16}$ in., at the same time making the rivet countersinks proportionately deeper.

This will enable you to remount the wheel on the turning spigot to turn off the surplus face, and so produce absolute flatness. It will entail the use of the lathe as a rotary shaper, that is to say, the work will have to be rocked to and fro past the tool, as the crank boss will not permit complete rotation of the wheel. In any case, it will be necessary to fill the interstices round the spokes with either molten lead or type metal. I prefer the latter for its clean working, and I made up a little copper pot on a long handle, with an extended spout, enabling me to decant the molten metal into the wheel when it was held vertically in the vice. I went through all the operations with the empty pot, making sure that its shape would allow the pouring of the metal without soldering my feet to the floor.

The visible holidays and peeps of daylight were first sealed off from inside with strands of asbestos string, and old scraps of type metal were melted and poured boldly in. I expected to find the plates would at least allow the metal to equalize in level, by running past the spoke faces in parts; but, in practice, I found it just as easy to pour into each section separately, until the level of the metal was about $\frac{1}{8}$ in. from the top edge of the plates.

It is not necessary to put any metal into the pockets formed by the last spoke on each side, with the "fade-out" portion of the plates, and there would be no key to hold it there in any case.

I might add that a little pre-warming of the wheel helps to prevent the too rapid cooling of the metal filling. Any stray runs of metal that have escaped are easily cleaned off, and visible portions of the asbestos string stopping may be picked out with a pin, if they show at all. It should not be necessary for me to state that the rivets should be finished flush, back and front and, if a tiny ring is left showing round the front rivet heads, it will conform to the prototype exactly.

The crankpins may now be turned up and pressed into the wheels, and the driving crankpin calls for an especially good press-fit. Not only does this member take the entire drive, but it must also be proof against any tendency to turn. The pin looks somewhat incomplete; but, later on, the return-crank will sit on the blank end of it, and will be fixed to it by means of the well-known L.M.S. "four bolt" fixing; this will entail the drilling of the four holes and tapping them—a job to be done *in situ*, and *after* the pin has been finally pressed in. Don't look so scared — it isn't very risky, and is one hundred per cent. essential for spot-on valve setting, so we will leave it at that.

The leading crankpin is drilled through and with its long bolt gives perfect security and super-neat appearance; the clearances here are very fine, as they are in most engines scaled down and, with the extra wheel float required for free axle side movement, the clearances are even more reduced. The potential fouling-point is where the leading coupling-rod and crankpin have to pass the back of the guide-bars, and I have seen indifferent forms of screws and thin nuts slack off until they begin to perform their own milling operations on the unfortunate parts of the motion work, that happen to be in the way.

The trailing wheel crankpin is of the conventional type with nut and washer, both of these being scaled down almost exactly, even if they do not look it on the drawing. In the choice of threads, I would certainly recommend the finer thread, that is forty per inch; I have found that there is a better chance of keeping the nuts tight against the turning action of the coupling rod, and on the off-side or "six foot side" the tendency to unscrew is positively there, when travelling forward—the direction of travel mainly used.

Provision has been made for the fitting of a small taper or split pin, the plain portion beyond the end of the thread being the place to drill for it, and not necessarily through the nut itself, although the prototype has a solid through-pinned nut.

As to paint finish, my view on wheels generally is that they should be painted early on and whilst they are easy to hold and free from obstruction. As a general guide, the finish should be a dull black (for this engine) in preference to a high-gloss finish.

The backs of the wheels should be painted

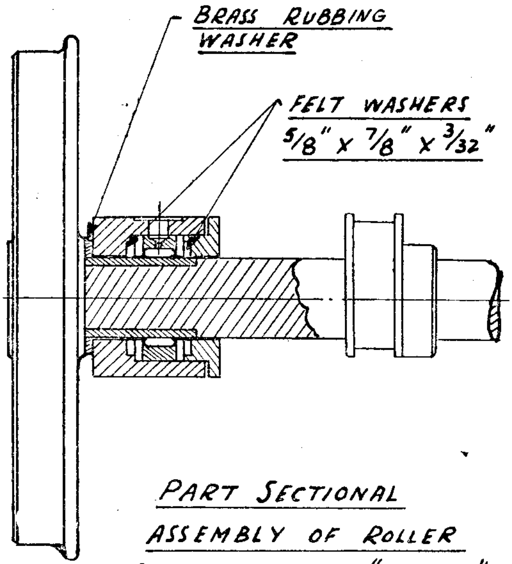
right out to the start of the radius of the wheel flange, leaving only the inside boss face clean. The front should be painted right over the crank face and out as far as the cham fer breaking the edge of the wheel tread.

Eventually, the face of the axle showing in the bore of the wheel will also be black. The photograph shows the whole ensemble, and there is no suggestion of the black making the wheels " heavy " and, to my way of thinking, they present a very neat and pleasing appearance.

At the start of this series, I made particular mention of a stove enamel finish that could be applied at home. I have been working hard on the manufacturers in trying to get supplies issued to the Trade ; at present, there are a number of difficulties in the way—technical and otherwise, but I have no doubt that, by the time the " Twin Sisters " boilers and plate work are ready, the solutions to these various problems will be found.

If you feel that you cannot wait for a somewhat indefinite solution to this major problem, then I recommend the use of " Roscoe " cylinder black, a material that can be obtained from almost any reliable motor-accessory concern. It gives a very satisfactory coat, apparently unaffected by heat, and has just about the right " texture " for small loco work.

And now, to change the subject altogether, I feel that a major recapitulation of the whole story is badly needed. The occasional hark back is often welcome, and in this case I have my thumb on the pulse of my readers as a result of a large number of very friendly, and often, helpful letters received. Some of these kind people have taken the trouble to tabulate small errors in the drawings, whilst others have suggested the use of alternative materials, where the metals or parts quoted have happened to be unobtainable. To all these writers I have replied personally, often giving the right away to their own ideas on substitutions. I know full well that materials like stainless steel do not grow on trees, but I am not to know that simple items such as $\frac{1}{16}$-in. iron rivets, simply cannot be bought in some areas. I live in a non-industrial area myself, right by the sea, and I try to make the specification of the engine as straightforward as possible. As a case in point for a surprising reversal in this position, I see one reader has even exceeded the requirements stated, and has made his stretchers in stainless material where mild-steel was ordered. There is nothing



PART SECTIONAL ASSEMBLY OF ROLLER AXLE BOX FOR "MAJOR"

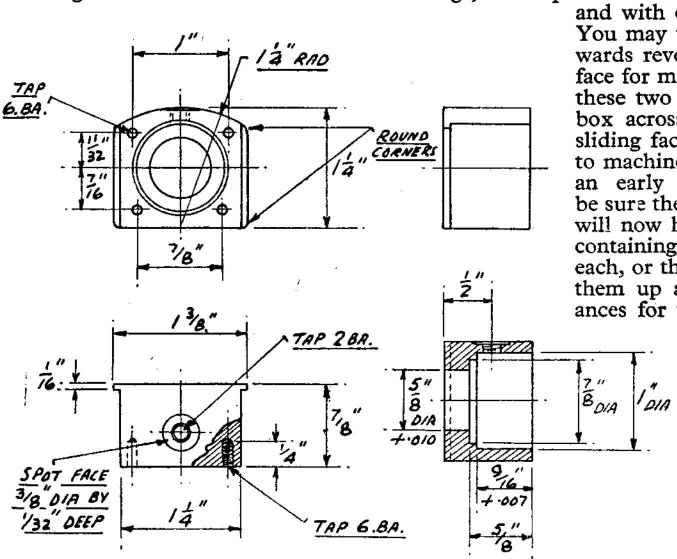
wrong with this, and good luck to him in his endeavour to obtain an even better job.

By far the greatest number of queries were centred round the problem of the " dummy versus real riveting," and in particular relation to my recommendation for the inside flanges of the stretchers. It serves to show that the man who is keen on really good detail, is not to be put off too easily, and in many ways I don't blame him.

In the particular instance in the building of the present engine, certain factors enter into the calculation, based on two main needs. They are the need for easy but safe assembly and therefore, at some future date, ease of dismantling for service, and an ever-present problem of finish—usually in the form of paint. In this latter connection, the ability to assemble ready-painted parts, and we hope, stove enamelled at that, is so important that its significance must not be too easily overlooked. There is just a world of difference between painting a permanently assembled pair of frames and a conveniently disposed set of parts. Even a quick look at a pair of frames and parts, painted by the latter procedure, leaves no doubts at all as to its complete superiority—in fact, there is just no comparison at all. On the score of strength, I feel confident that a number of years I spent in the design office of one of our leading aircraft firms, has fitted me to deal with these simple bolt and rivet stress cases. Personally, I would never dream of telling a technical man that his design was all wrong, and when I specified plain buffer planks for my engine, I did so with the knowledge that, in the event of a bad collision or fall, the plain strip beam would bend where an angle beam would not. For this very reason, I specify a plain plank and let the technical people work out the answer that is not very difficult to find. Returning to the problem of bolt and rivet fixings, I mentioned quite early in the series that the engine was being built more or less concurrently with the writing of the series, and it has the advantage of letting you see the photographs of the job in its interesting stages of development. Being also a new venture, I did not benefit by having had some months of prior construction work in hand ; but, long before this description is complete, a new locomotive will have come into being, and its smallest details will be settled (I hope), which will do away with the necessity for the calling up of extra holes here and additional fixing there—

a state of affairs that is liable to exist during this present story. I do not anticipate any of these later alterations, but I would be compelled to make them rather than take the risk of spoiling the finished job.

If you look at the latest photograph of the "Twin Sisters" posed side by side, you should be able to discern quite a deal of the detail. The engine in the foreground is Mr. A. Duncan's job—a very first attempt at building a locomotive, and he has achieved this entirely by himself; the only help he has had, has been by word of mouth, and yet it is difficult to distinguish it from my own attempt in the background. I want to take this opportunity to tell you that both engines are fitted with the roller-bearings,



ROLLER AXLE BOX FOR "MAJOR"
6 OFF — IN GUNMETAL

and they work very sweetly indeed, and gave not a spot of bother in the actual making. On completion of this item, his and my impression was "Is that all there is to it?" The working leafsprings are another simple job, and the calculated tension appears to be just about right, although the final weights to be carried have not been accurately estimated.

The most recent and fully justified "grumble" relates to the need for some quantitative specification of the materials to be needed on the job. I fully agree with this and, although it would be difficult to incorporate this in the series running, I intend to deal with this in the future. To satisfy present conditions, materials that are likely to be difficult to find will be detailed as much in advance as possible; in fact, any points having any bearing on the ease of mind of the present builders, will have the most careful consideration. And, with that last profound thought, we will get back to business.

It is the same old chase all over—once the wheels are finished, you just can't wait for the axles and the first sight of the little job standing on its own feet at last.

For "Major," start on the axleboxes first, machining the long bar of gunmetal down all four sides. Planing, shaping or milling needs no comment, but end-milling in the lathe most certainly does.

There are a very few lathes that have a cross-slide with a 10-inch travel, and if you intend to travel it past an end-mill held in the chuck, there are two courses open to you. If your cross-slide has a travel less than the diameter of the largest workpiece you can swing in the gap of the lathe, then cut the bar in two for preference, or into three equal parts if you must, and chuck the piece in the four-jaw chuck, by its middle and with one of the thin edges outwards. You may then face the length held, afterwards reversing it to present the opposite face for machining. The dimension across these two faces must be that of the axle-box across the two flanges, and *not* the sliding face size. Again chuck each piece to machine the other two faces, and make an early check with a small square to be sure the shape is not "diabolical." You will now have either two chunks of metal containing sufficient for three axle-boxes each, or three chunks of two each. Divide them up accordingly, making due allowances for the thickness of the saw blade, and continue with the four-jaw chuck treatment for facing off the rough ends where divided. You should now have six blocks, machined all over, the right height, width and length, and requiring only the end-milling of the two sliding edges to complete the flat machining operations.

End-Milling

The blocks may now be held in the cross-slide, packed up to a height to allow the side of the end-mill to leave the $\frac{1}{16}$-in. fillet; this operation might even be carried out before the pieces of bar are divided up as suggested, and depending upon whether the cross-slide has enough travel to do the job in one bite. If it is possible to arrange a fixed metal strip on the top of the slide, and set and arranged to form a permanent edge against which the block or bar is held, you have a better chance of getting not only uniform results, but sides that are parallel with each other, provided always that the guide is set dead square.

It may also save time in setting up separately for six items, depending on how long it takes you to fix the strip.

If you doubt your ability to secure uniform results, leave each piece a little full, and use a smooth file to take the last few thousandths off each side equally; fit each block to its own pair of horn-cheeks, seeing that both block and cheeks are marked or numbered.

(*To be continued*)